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# COLORADO RIVER BASIN PROJECT

TECHNICAL SESSION, DENVER, COLORADO

APRIL 14-15, 1965

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1965

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TECHNICAL SESSION

# COLORADO RIVER BASIN PROJECT

DENVER, COLORADO
APRIL 14-15, 1965

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service
REGION VIII – DENVER, COLO.

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TECHNICAL SESSION
Colorado River Basin Water Quality Control Project
Denver, Colorado - April 14-15, 1965

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# TECHNICAL SESSION

## COLORADO RIVER BASIN PROJECT

This document has been prepared to illustrate the approach and objectives of the Project's pollution study in a coordinated and comprehensive manner, and in as much detail as is now possible. It will serve as a guide to the several portions of the study and will acquaint other interested parties with the total scope of this program. Comments or suggestions are welcomed.

It is anticipated that this document will be revised at appropriate times as the study progresses and experience permits the definition of the elements in more detail.

U. S. Department of Health, Education, and Welfare
Public Health Service
Division of Water Supply and Pollution Control

Region VIII
Colorado River Basin Project
Denver, Colorado

April 1965

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# PROGRAM CONTENT

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SUMMARY OF CONFERENCE
(FIFTH SESSION)

POLLUTION OF INTERSTATE WATERS

OF THE

COLORADO RIVER AND ITS TRIBUTARIES
(COLORADO-UTAH-ARIZONA-NEVADA-
CALIFORNIA-NEW MEXICO-WYOMING)

MAY 26, 1964

The fifth session of the conference in the matter of pollution of the interstate waters of the Colorado River and its tributaries (Colorado-Utah-Arizona-Nevada-California-New Mexico-Wyoming) was held on May 26, 1964, at Las Vegas, Nevada, under the provisions of section 8 of the Federal Water Pollution Control Act (33 U.S.C. 466 et seq.). The first session was held on January 13, 1960, in Phoenix, Arizona; the second session on May 11, 1961, in Las Vegas, Nevada; the third session on May 9 and 10, 1962, in Salt Lake City, Utah; and the fourth session on May 27, 1963, in San Diego, California.

The Colorado River rises high in the snow-capped Rocky Mountains of north central Colorado near the Continental Divide. It flows generally southwesterly for some 1,400 miles before emptying into the Gulf of California in Mexico. The river flows across Colorado into Utah and later forms parts of the boundaries between Arizona and Nevada, and Arizona and California. It has some sixty tributaries and drains not only parts of the five States named but also parts of New Mexico and Wyoming.

The following conferees representing the State water pollution control agencies of Colorado, Utah, Arizona, Nevada, California, New Mexico, and Wyoming, and the U.S. Department of Health, Education, and Welfare, attended the fifth session of the conference:

George W. Marx — Arizona State Department of Health
Phoenix, Arizona

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|---|---|
| Paul R. Bonderson | California State Water Quality Control Board<br>Sacramento, California |
| Frank Rozich | Colorado State Department of Public Health<br>Denver, Colorado |
| Wallace W. White | Nevada State Department of Health<br>Reno, Nevada |
| Charles D. Caldwell | New Mexico Department of Public Health<br>Santa Fe, New Mexico |
| Lynn M. Thatcher | Utah Water Pollution Control Board<br>Salt Lake City, Utah |
| Arthur E. Williamson | Wyoming Department of Public Health<br>Cheyenne, Wyoming |
| Lester M. Klashman | U.S. Department of Health, Education, and Welfare<br>Denver, Colorado |
| Murray Stein, Chairman | U.S. Department of Health, Education, and Welfare<br>Washington, D.C. |

Also participating in the fifth session of the conference were the following:

| | |
|---|---|
| Henry Baty | Atlas Mineral Division<br>Atlas Corporation<br>Moab, Utah |
| Robert G. Beverly | Union Carbide Corporation<br>Nuclear Division<br>Grand Junction, Colorado |
| William P. Copple | Arizona Water Users<br>Yuma, Arizona |
| William T. Davoren | U.S. Department of the Interior<br>Pacific Southwest Region<br>Salt Lake City, Utah |
| Joseph W. Fitzpatrick | U.S. Department of Health, Education, and Welfare<br>Colorado River Basin Water Quality Control Project<br>Denver, Colorado |
| John B. Goff | AZ Minerals Division<br>Atlas Corporation<br>Moab, Utah |

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|---|---|
| Don F. Harmon | U.S. Atomic Energy Commission<br>Washington, D.C. |
| Roswell Jones | Arizona Water Company<br>Phoenix, Arizona |
| Maurice N. Langley | U.S. Department of the Interior<br>Bureau of Reclamation<br>Washington, D.C. |
| Robert P. Lowe | New Mexico Department of Public Health<br>Santa Fe, New Mexico |
| John M. Rademacher | U.S. Department of Health, Education, and Welfare<br>Colorado River Basin Water Quality Control Project<br>Denver, Colorado |
| Charles Sponagle | U.S. Public Health Service<br>Denver, Colorado |
| Dr. E. C. Tsivoglou | U.S. Public Health Service<br>Cincinnati, Ohio |
| Dr. Nathaniel Wollman | University of New Mexico<br>Albuquerque, New Mexico |

The Chairman of the conference pointed out that:

1. Under the Federal Water Pollution Control Act (33 U.S.C. 466 et seq.), pollution of interstate waters which endangers the health or welfare of persons in a State other than that in which the discharges originate is subject to abatement under the procedures described in section 8 of the Federal Act.
2. The first step of this procedure is the calling of a conference.
3. The purpose of the conference is to bring together the States and the U.S. Department of Health, Education, and Welfare to review the situation, to lay a basis for future action by all parties concerned, and to give States and localities an opportunity to take any indicated remedial action under State and local law.

4. At the first session of the conference on the interstate waters of the Colorado River and its tributaries, held on January 13, 1960, in the Phoenix Library Auditorium, Phoenix, Arizona, the U.S. Department of Health, Education, and Welfare agreed to undertake, in cooperation with the States and other Federal agencies, an investigation and study to define the pollution problems that might exist in the interstate waters of the Colorado River and its tributaries; to include, among other things, a determination of specific pollutants and their concentration, and methods of securing the best possible water quality for multiple uses. The U.S. Department of Health, Education, and Welfare further agreed to present a detailed proposed plan of study and investigation to the States and Federal agencies for review and comments.
5. At the second session of the conference, held on May 11, 1961, at the Stardust Auditorium, Las Vegas, Nevada, the status of study and investigation was reported.
6. At the third session of the conference, held on May 9 and 10, 1962, at the Auditorium, New State Office Building (Capitol Hill), Salt Lake City, Utah, reports were made on the status of investigation, study, and remedial action.
7. At the fourth session of the conference, held May 27, 1963, in San Diego, California, reports were made on the status of investigation, study, and remedial action, and further activities for the Project were planned, including particularly an intensive study of salinity problems in the River.

At the fifth session of the conference, held on May 26, 1964, in the Stardust Hotel, Las Vegas, Nevada, the status of investigation, study, and remedial action was discussed, and the following activities were recommended for the coming year:

1. The Project staff will prepare a statement of the basic principles to be used in the formation of a comprehensive pollution control plan, for submission to the Technical Committee and the conferees by July 26, 1964.

2. Out-of-Basin areas served by Colorado River water are to be included in the Project's economic evaluations, considered particularly in relation to increased costs as well as limitations on water use resulting from salinity and other pollution of the Colorado River system. The Technical Committee at its next meeting will determine which of these out-of-Basin service areas are appropriate for inclusion in the Project.
3. The Project will investigate and report on the changes in water quality, insofar as these changes affect recreation, domestic or public water supplies, and fish and fishing, caused by upstream uses of water and reduction in volume in Lake Mead and Lake Powell.
4. In continuation of the activities of the previous year, the Project staff will assess the nature and magnitude of the salinity build-up in the main stem of the Colorado River and its tributaries; investigate and evaluate feasible methods of controlling and minimizing salinity concentration loads in the River; and evaluate the net Basin-wide economic benefits associated with various degrees of salinity control.
5. A full report on the effects of pesticide applications on the interstate waters of the Colorado will be prepared by the Project staff for consideration by the Technical Committee at its next meeting.
6. The Project staff, with the Project's radioactivity consultant, will prepare before the next session of the conference a detailed report on radioactive wastes in the Basin. The report will review every tailing pile and pond in the Basin, evaluate each one as to whether a hazard is created, and recommend the necessary remedial action, if any, in each case. The report will also indicate the general prognosis for the health and safety of the Basin population in relation to the radioactive waste disposal problem.
7. The Project will study and evaluate the effects of uranium on fish.

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8. The Project's radioactivity consultant, in cooperation with the Atomic Energy Commission and the State water pollution control agencies concerned, will meet with representatives of the AZ Minerals mill at Mexican Hat, Utah, and the Union Carbide Nuclear Company mill at Rifle, Colorado, to discuss proposals for remedial action which may be necessary to control radioactive pollution in the Mexican Hat and Rifle areas.
9. For the next session of the conference, the Project staff will prepare a report with suggestions for the phasing out of the Project.
10. The conference will be reconvened at the call of the Chairman.

## PROGRAM CONTENT

### LONG RANGE GOALS

The Colorado River Basin Water Quality Control Project is a pollution study in the traditional pattern, in that it is concerned with (1) identification of pollution sources, (2) estimation of effects of pollution on legitimate water uses, and (3) development of feasible pollution controls. The Project is attacking one of the specific pollution problems of the Colorado--salinity--through the use of a program combining engineering and economics.

The Project's engineering activities are directed toward the identification of pollution sources, the assessment of damages due to pollution from salinity, and the development of feasible control measures for all sources of salinity pollution, whether they be agricultural, municipal, industrial, or natural.

The economic study is projecting the level and pattern of economic activity for the years 1965, 1980, and 2010 by means of interindustry input-output tables. An analysis of water quantity as a constraint on the level and pattern of economic activity is also underway, using expected water demands for the periods 1965, 1980, and 2010. An analysis of the relation of benefits to costs, based on present and projected future water quality with various combinations of programs for control of salinity sources, is an integral element in merging the engineering-economic components. Using the economic projections similar analyses will be made for the periods to 1965, 1980, and 2010, taking cognizance of changes decreed by the U. S. Supreme Court's allocation of water and the development of various water resource projects proposed by various construction agencies within the study period.

It is anticipated that a program for the control of pollution for the interstate waters of the Colorado River Basin and its tributaries can be

recommended to the Conferees during Fiscal Year 1967. The justification for any measures recommended to control saline pollution will be based on the adverse effects of such pollution on the development of the Colorado River Basin.

A more detailed description of the Project's operation is given in the following outline of the several operating programs and contracts. The Project activities sequence charts which follow explain the sequential basis for accomplishing Project objectives. Each operating section, whether it be Pollution Control Benefits, Pollution Control, the Field Station, the Laboratory, the Economic Contractors, or Radiological Pollution Control, has been scheduled to provide the necessary information in accordance with this sequence.

Pollution Identification Program. The Field Station, located at Phoenix, Arizona, develops and analyzes data and prepares interpretative reports directed primarily toward identifying the major salinity sources in the Colorado River Basin and characterizing the salinity discharges from these sources. Involved in this activity are a sampling program integrated with flow-gaging stations, intensive special-purpose studies in selected areas, and the collection of relevant information on environmental factors such as rainfall, runoff, geology, soil types, groundwater conditions, irrigation practices, and other water uses. Irrigation drainage returns, springs, brine seeps, and the natural products of the weathering of rocks and soils are included, as well as water losses that degrade the quality of the remaining supply.

Some of this information is available from other agencies and has been used to provide a broad picture of water quality changes with respect to time and distance. The Project must, in addition, pinpoint specific sources of pollution, and for this purpose further data has had to be collected. Long-range patterns of water quality changes have been analyzed, using all available data and special reconnaissance surveys. Based upon these analyses and surveys,

the field program has been designed to identify those areas where significant water quality changes occur. The field staff then assembles water-use information for those areas so that a definitive picture of pollution contributions can be developed.

A sketch of the pollution source identification program can be seen in the maps of the Lower and Upper Colorado River Basins on Pages 37 and 38 of this document. Results from samples collected for the past year from forty locations in the Lower Main-Stem Sub-Basin are now being evaluated. Thirty-three of these locations were sampled by Project personnel and seven by other cooperating agencies. The current program involves sampling at 111 locations in the Upper Basin (74 by the Project, 37 by USGS and USBR). The USGS furnishes flow data from 62 permanent flow measurement stations. In addition, 13 nonrecording gages have been established and stage-discharge measurements are being made by USGS for the Project. Quality data is also available from more than 100 other locations being sampled by the Bureau of Reclamation. Cooperative sampling programs are being carried out in several areas in the Upper Basin in order to avoid duplication of effort. In addition, two locations on the Little Colorado River are being studied by the Project and water quality information is being received regularly from the U. S. Geological Survey for six locations in the Gila River Sub-Basin. At present eight municipal and twelve industrial waste sources are being evaluated by the Project in the Upper and Lower Basins.

Analyses are performed on the samples submitted to the Project Laboratory for the following parameters:

| | | |
|---|---|---|
| Conductivity | Sodium | Chloride |
| pH | Potassium | Sulphate |
| Calcium | Bicarbonate | Total Dissolved Solids |
| Magnesium | Carbonate | Total Hardness |

In addition to these analyses, other analyses to identify organics, pesticides, and radionuclides have been made at selected points for specific purposes. These will also be continued on a need basis.

Pollution Control Benefits. Pollution damage and control benefits are being assessed in the three major areas of greatest existing or potential economic development, i.e. southern California, central Arizona, and southern Nevada. The task of damage assessment is to appraise the physical and economic effects of salinity and hardness on the principal beneficial uses of water, existing and potential, in the Colorado River Basin. Physical effects involve any modifications in the environment and in human activities imposed by changes in water quality. Economic effects involve direct costs to the user as a result of water quality degradation for any given production process. Production process in this context refers to all water uses, domestic, industrial, agricultural, and other. Economic effects also include net losses incurred from necessary shifts in production processes or crop patterns, etc., which must take place as the result of water quality degradation.

The importance of the central concept of "pollution damage assessment" may be exemplified in the following program for analyses of agricultural and municipal uses. Damages due to past increases in hardness and salinity between a selected base period and 1964 have been estimated, for example, for the Lower Main Stem Sub-Basin of the Colorado. Damages which will arise from anticipated future degradation of mineral quality of water supplies, between 1964 and 2010, have also been calculated in part.

Salinity damages are being calculated for three types of water supplies: agricultural, municipal, and industrial. This report deals with the premises and methods used to evaluate penalty costs of mineralized water in those three uses of water.

Agriculture. Three significant damages incurred by agricultural water users due to high salinity concentration in irrigation water were considered: (a) leaching requirements, or the need for water, in addition to consumptive use requirements, to leach salts out of the soil and prevent a salt accumulation in the root zone that would result in a crop yield decrement in excess of 10 percent; (b) drainage requirements, or the drainage facilities necessary to handle the leach water; (c) fertilizer losses, or the amount of fertilizer, particularly nitrogen, lost in the process of leaching the soil. The methods and assumptions used to evaluate the three types of agricultural penalty costs are discussed in the following paragraphs. Increase in salinity has the tendency to increase water requirements for leaching, thus increasing both monetary costs and volumes of water.

Leaching Requirements. The amount of water necessary to provide proper leaching has been calculated using formulae developed by the U. S. Department of Agriculture's Salinity Laboratory at Riverside, California. The methods, assumptions, and values used in the calculations for leaching requirements were reviewed and found acceptable by a Project Consultant, Mr. Lloyd V. Wilcox, former Deputy Director, U. S. Salinity Laboratory, USDA.

Drainage. Information received from the managers of several irrigation districts indicates that land that has a water table 4 to 6 feet below the ground surface is marginal as to drainage need. This land will require drainage in the future if additional water is put on the land for leaching purposes. Information on the location of the groundwater table, the proper drain spacing, and the cost of drainage facilities was obtained from the various irrigation districts.

Two separate costs are included in the total annual drainage penalty cost: (1) capital construction, (2) maintenance and operation. The cost of drainage facilities that will be needed in 2000 can be calculated with the amount of drainage necessary and the unit cost of drainage facilities. It is assumed that the need for additional drainage facilities in the future is recognized now and that a sinking fund will be established in order that the necessary money will be available in 2000. The annual payment to the sinking fund is the annual penalty cost due to the necessary capital construction. The maintenance and operations costs are established by calculating the cost per acre in each irrigation district over the past few years, and applying the average value to the number of acres that will need drainage in the future. The average cost per acre for maintenance and operation of drainage facilities varies with each district. The sum of the annual sinking fund payment and the annual maintenance cost gives the total annual penalty costs for additional drainage.

Fertilizer. Average rates of fertilizer application and unit cost values were developed by the Field Station staff and are used in the evaluation. The annual penalty cost reported is the difference between the 1964 annual cost and the 2000 annual cost.

Approximately 29-45 percent of nitrogen fertilizer applied can be lost if leaching is practiced. These two values were used to calculate the maximum and minimum losses in 1964. In the future when greater quantities of leaching water are applied to the land, more nitrogen will be lost. For the year 2010 it is assumed that the additional nitrogen loss will be proportional to the greater amount of leaching water applied. This assumption is believed to be conservative.

Municipal. Present damages to municipal uses were estimated relative to pristine conditions prior to modern economic development. Future damages were based on the anticipated increase in hardness concentration from the present to the year 2000.

Taste. The salinity "taste" is highly unsatisfactory to many people, leading to demands for either desalinization plants or new and distant sources of water.

Evaluation of Present and Projected Damages Due to Hardness. Hard water has many deleterious effects on consumers including increased soap consumption, scaling, accelerated fabric wear, etc. However, only a few of these effects can be evaluated quantitatively in light of present knowledge.

Increased hardness in the domestic water supply will cause an increase in the cost of operating a home water softener for that portion of the citizenry using home units. For example, 20 percent of the residents of Yuma, Arizona, presently use home softeners. Since the water is projected to become harder, this 20 percent of the population will pay a higher cost per 1000 gallons softened. Therefore the incremental damage to this portion of the populace is the difference between the cost per 1000 gallons they will pay in the year 2000 and the cost per 1000 gallons they are currently paying.

Another result of increased hardness will be that home softeners will become more prevalent. Thus, the annual damage to those people who will be induced to use home softeners in response to the increased hardness is the annual cost of renting a unit or the amortized cost of purchasing and generating the unit.

Wastage of Soaps and Detergents. The gross savings in detergents, soaps, and other cleaners per capita per 100 ppm hardness reduction has been estimated at $1.15 per year, in an article based on water uses in Illinois.

In the Colorado Basin, where water use for purposes requiring softened water is higher per capita, it is further estimated that the saving would be $1.28 per capita per 100 ppm hardness reduction.

Central Softening Plants. The estimated present and projected cost of municipal softening is based on an article by Howson, "Economics of Water Softening." He estimates the cost of central softening to be $.05 per 1000 gallons for the first 100 ppm hardness reduction and $.0125 per 1000 gallons for each subsequent 100 ppm hardness removed. These figures are for plants whose capacity exceeds 20 mgd. The unit treatment costs increase for plants with smaller capacities.

In its assessment of damages the Pollution Control Benefits Section is also responsible for developing a comprehensive picture of water uses in the Colorado River Basin and its tributary areas. Coupled with this water use inventory is an appraisal of the water quality parameters which should be evaluated for each legitimate water use.

Pollution Control Studies. A waste source inventory, being developed by the Pollution Control Section, will identify the significant municipal, industrial, agricultural, and natural waste sources in the Basin. Pollution control measures are being considered for the most significant sources. Methods of pollution control which are being considered include (1) preventing natural brines from entering the main stem or tributaries; (2) dilution of salts by regulating streamflow, which involves a network of reservoirs and operating schedules; (3) reducing water losses from evaporation and evapotranspiration; (4) lessening the contribution of highly saline groundwater to the streams by control of groundwater hydraulics, for example, minimizing the use of excess irrigation water and decreasing canal conveyance losses which percolate to the groundwater table and raise it; and (5) limiting the practice of using water in excess of needs for various purposes.

Close coordination with those agencies having construction and research responsibilities in these areas is considered an important requirement in the success of this program. Each significant pollution source is being evaluated with respect to its relative effect on water quality, the engineering feasibility of its control, and the associated cost.

Economic Studies. An economic study of the Colorado River Basin is being conducted under two major contracts, as a means of assessing present and potential economic consequences of salinity pollution. It is anticipated that the major portion of the economic contracts will be completed by August 1965. An extension of the contract will be necessary to complete the analyses for quality constraints on the Colorado River Basin economy and to merge the engineering-economic elements of the Project program.

University of New Mexico. A contract with the Department of Economics calls for the development of forecasts of economic activity in the Colorado River Basin using interindustry input-output tables. The Project's economic contractor was selected because of his intimate associations and familiarity with the development of the Colorado River Basin. Economic sectors including government, trade, services, and utilities, as well as the overall job of coordinating the work of the various economic study participants, are the responsibilities of the New Mexico group. A subcontract with the University of Colorado's Institute of Behavioral Science, to prepare the input-output tables and the projections of the manufacturing and mining sectors have been let by the University of New Mexico. Population projections for the Colorado Basin are being prepared by Dr. William Leasure of San Diego State University.

Economic Research Service, U. S. Department of Agriculture. Under a memorandum of understanding with this agency, the Project has contracted to obtain agricultural projections and agricultural components for the input-output tables.

Radiological Pollution Control. The primary concern of the states during the first years of the Project was radioactive pollution from industrial and natural sources. At the fourth and fifth sessions of the Conference, in May 1963 and May 1964, the Conferees were informed that the Colorado River's radioactive content is consistently below those levels recommended as maximum for drinking water by the Public Health Service. A surveillance network of monitoring stations has been established to detect radioactivity and insure protection of downstream water users. Special studies included in this activity are the evaluation of radiochemical concentrations in river sediments, farm fertilizers, and consideration of the problem of ultimate disposal of uranium mill tailings.

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ACTIVITIES AND ACCOMPLISHMENTS THROUGH FY 1965

Accomplishments through January 1, 1965

Project progress is measured not only in achievement of planned objectives, but also in overcoming major obstacles. For a period of almost four months the Project activities were subjected to stringent restrictions as the result of Section 206 of the 1965 DHEW Appropriations Act. The President's Science Advisory Committee was required to pass on the expenditure of funds by the Project for salinity and irrigation water quality studies. After intensive review by a special panel from the Committee, unqualified approval was given to the Department in these activities.

Investigation and recommendations by a Colorado River Basin Project staff member concerning an incipient oil brine pollution problem in the vicinity of the Ouray Wildlife Refuge near Vernal, Utah, resulted in a cooperative correction program involving the industry, Federal, state, and local people. Our involvement came at the direct request of the Regional Director, Bureau of Sports Fisheries and Wildlife.

Since November 1964, the Bureau of Reclamation, Region IV, Salt Lake City, has carried out cooperative arrangements with the Colorado River Basin Project field staff to dovetail sampling operations to minimize duplication of effort.

The Bureau of Reclamation has given recognition to benefits from flow augmentation for quality control in its Central Utah Project. This

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hitherto unprecedented acceptance was based directly on reports prepared by the Regional Office and Colorado River Basin Project staff for that project.

Under a contract with Colorado State University, a mileage coding for data retrieval for the Colorado River Basin has been completed.

At the fourth and fifth sessions of the Conference, in May 1963 and May 1964, the Conferees were informed that the Colorado River's radioactive content is consistently below those levels recommended as maximum for drinking water by the Public Health Service. Within a period of three years, close cooperation between the seven states of the Basin, DHEW, several mining and milling industries, and the Atomic Energy Commission brought about this improvement through effective control.

The Project has made significant progress during the past year. Salinity load sampling has been completed for the Lower Main-Stem. The statistical analyses for time and distance trends are essentially complete for the Upper and Lower Basins; approximately 10 significant areas of salinity build-up and 27 major natural sources were defined; an inventory of salinity sources was prepared; preliminary reports on proposed methods of salinity control for Paradox Valley and the Virgin Rivers were prepared; assessment of damages to water uses in the Lower Main-Stem are 75 percent complete - for the Colorado River water service area in Southern California about 25 percent complete; projections of domestic water demand have been completed for 1980 and 2010 in all counties of four sub-basins; preliminary estimates of future water demand for the six major manufacturing categories in the Basin have been made; and the laboratory has performed 15,210 analyses

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on 1,228 inorganic samples and 2,098 determinations on 728 radiochemical samples.

The Economic Contractor has completed the population forecasts for all sub-basins; essentially completed the preliminary input-output tables for all sub-basins; is about 30 percent complete on the final input-output tables; and is essentially on schedule for the final demand sector of the preliminary projections.

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Stream Measurement Studies

Sampling programs have been developed for each of the six sub-basins to determine the current nature, magnitude, and distribution of saline pollution in natural streams. The results of the statistical analysis of historical data on water quality are used in selecting appropriate salinity load sampling sites. Permanent stations are established at key locations where sampling is carried out for at least one full year. Temporary sampling stations are utilized at less important locations where short-term sampling will provide adequate data.

A detailed review has been made of all existing quality and stream flow data for the sub-basins. Tentative salinity load sampling programs have been formulated for streams in each sub-basin. The sampling programs are reviewed with representatives of the U. S. Geological Survey and other interested agencies. When possible, existing stations at which quality data is being collected by other agencies have been incorporated into the salinity load sampling programs in order to minimize duplication of effort. In the development of the final sampling programs, a field reconnaissance has been made of each sub-basin at which time each sampling point was evaluated and a definite location selected for collecting samples. Maps, showing the location of all sampling sites, and a detailed description of each station have been prepared. Prior to initiation of sampling in each sub-basin, the station's proposed salinity load sampling program, station descriptions, together with information pertaining to proposed sampling frequency, were

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submitted to the Chiefs of the Pollution Control Benefits and Pollution Control Sections for review in order for them to determine whether or not the proposed sampling program will provide the data needed by their sections. Their recommendations have been incorporated into the final sampling programs. The Physical and Engineering Science Unit, Technical Services Branch, Division of Water Supply and Pollution Control, was requested to provide technical assistance on the design of the sampling programs and data analysis.

Arrangements were made for obtaining stream flow records from other agencies for as many sampling locations as possible. Where the need exists, additional stream gages were established. In many situations it was possible to arrange for the U. S. Geological Survey to install the necessary gages.

At stations which are sampled by station personnel, grab samples will be collected at weekly or two-week intervals depending upon their accessibility and relative importance, and the frequency required to provide the input data needed. Aquatic samplers are utilized to the fullest extent possible for collection of samples and related activities, such as conductivity measurements and servicing of conductivity recorders.

The salinity load sampling activities which were initiated in the Lower Main Stem and Little Colorado River Sub-Basins during FY 1964 were continued into FY 1965 (see map showing sampling sites. Based upon an analysis of analytical results obtained, seven sampling sites in the Lower Main Stem Sub-Basin were found to be redundant or insignificant and were eliminated during the summer. Sampling was discontinued at the end of October at all stations below Hoover Dam, since a full year of quality data had been collected at these sites. Sampling at stations above Hoover Dam as well as

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those in the Little Colorado River Sub-Basin was continued through January 1965 at which time one year of data had been accumulated.

Through field surveys and sampling programs, data was obtained on salinity contributions from the major irrigated areas in the Lower Main Stem Sub-Basin. A draft of a report was prepared explaining observed past and present salt and flow imbalances in the Parker Dam-Cibola reach of the Colorado River. Reconnaissance work and planning activities were initiated on the evaluation of salinity sources associated with irrigation in the Green, San Juan, and Upper Main Stem Sub-Basins.

Detailed field reconnaissance and evaluation studies were completed for the Gila Sub-Basin which showed that the major increases in salinity concentrations in the Gila and Salt Rivers occur above the major impoundments and downstream from the Arizona-New Mexico Border. No evidence of significant interstate pollution was found in the upper reaches of the Gila River. The reaches of the river where significant natural or man-made sources of salinity occur were delineated; however, they are confined primarily to the State of Arizona.

Field work required for the Little Colorado Sub-Basin was also considerably less than originally anticipated. Thus, it was possible to initiate Field Station activities in the Green, San Juan, and Upper Main Stem Sub-Basins during FY 1965.

Bi-weekly conductivity monitoring of municipal effluents was continued through January 1965 at St. George, Utah; Las Vegas, Nevada; Needles, California; and Yuma, Arizona. Samples for chemical analysis were also collected from each

of these four municipal effluents during December. A survey of the Upper Colorado River Basin was made during November for the purpose of updating the municipal and industrial waste inventory data that were collected by Project personnel several years ago. During this survey, samples for chemical analysis were collected from 30 municipal effluents and four industrial effluents. Salinity loads contributed by these sources were computed and those sources of significance will be monitored by bi-weekly conductivity measurements and sampled quarterly for chemical analysis.

A preliminary report entitled "Short-Term Study of Chemical Precipitation in the Lower Colorado River" was prepared covering the cooperative survey conducted by personnel of the Project and U. S. Geological Survey during the period February 18-27, 1964. It was concluded that there was no chemical precipitation other than calcium carbonate during the period of the study, within the Hoover Dam-Northerly Border reach of the Colorado River. Further office studies are in progress to estimate the net change in salt burden and change in proportions of constituent ions, indicative of the effects of agricultural use.

During the Fifth Session of the Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries, the conferees requested that the analytical results of the Project's salinity sampling program be made available to them. Tabulations of laboratory results for all salinity samples collected through September 1964 have been sent to the conferees.

Sampling programs were developed to determine the nature, magnitude, and distribution of saline pollution in natural streams within the Upper Colorado River Basin (see map showing sampling sites. Salinity load sampling

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activities were initiated by Field Station personnel during October 1964 in the Green, San Juan, and Upper Main Stem Sub-Basins. Arrangements were made to have the U. S. Geological Survey install wire-weight gages and make flow measurements at 13 sampling sites where no flow data are available.

It is expected that all major Field Station activities in the three lower sub-basins of the Colorado River will be completed by the end of FY-1965 (see work programming and personnel utilization charts). Field Station activities in the Green, San Juan, and Upper Main Stem Sub-Basins will be expanded and intensified during the remainder of the fiscal year. The statistical analysis of existing water quality data for these three sub-basins will be completed by the middle of April. Salinity load sampling and other field activities pertaining to the identification and evaluation of salinity sources and the evaluation of salinity concentration factors will proceed at increasing tempo in the Upper Colorado River Basin.

A field depot has been established at Grand Junction, Colorado in March 1965 to facilitate field work in the Upper Basin. This depot will be used primarily for the storage of field equipment and supplies and for the repair and maintenance of conductivity recorders and other equipment. It will also serve as an operating base for field personnel. Two engineers, an engineering technician, two aquatic sample collectors, and a laboratory mechanic will be detailed to Grand Junction to carry out salinity load sampling, intensive surveys and other field activities in the Upper Colorado River Basin.

The Field Depot at Grand Junction will be phased out upon completion of field studies in the Upper Basin.

# WATER POLLUTION SAMPLING SITES

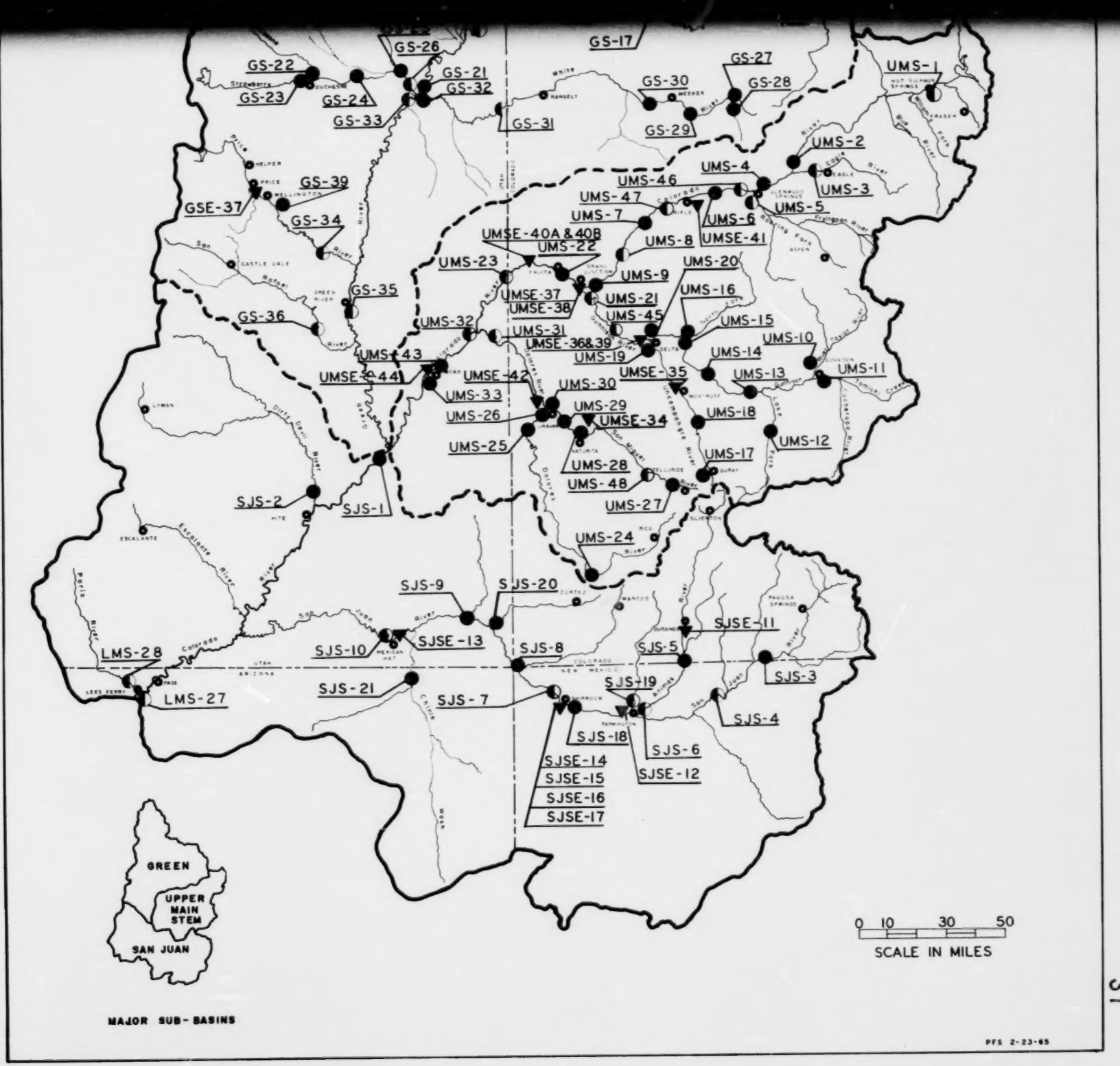
## UPPER COLORADO RIVER BASIN

### COLORADO RIVER BASIN WATER QUALITY CONTROL PROJECT

PUBLIC HEALTH SERVICE

U.S. DEPT. OF HEALTH, EDUCATION, & WELFARE

REGION VIII DENVER, COLORADO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GSE-37
GS-34
UMSE-40A&40B
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UMS-8
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UMSE-36&39
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# WATER POLLUTION SAMPLING SITES

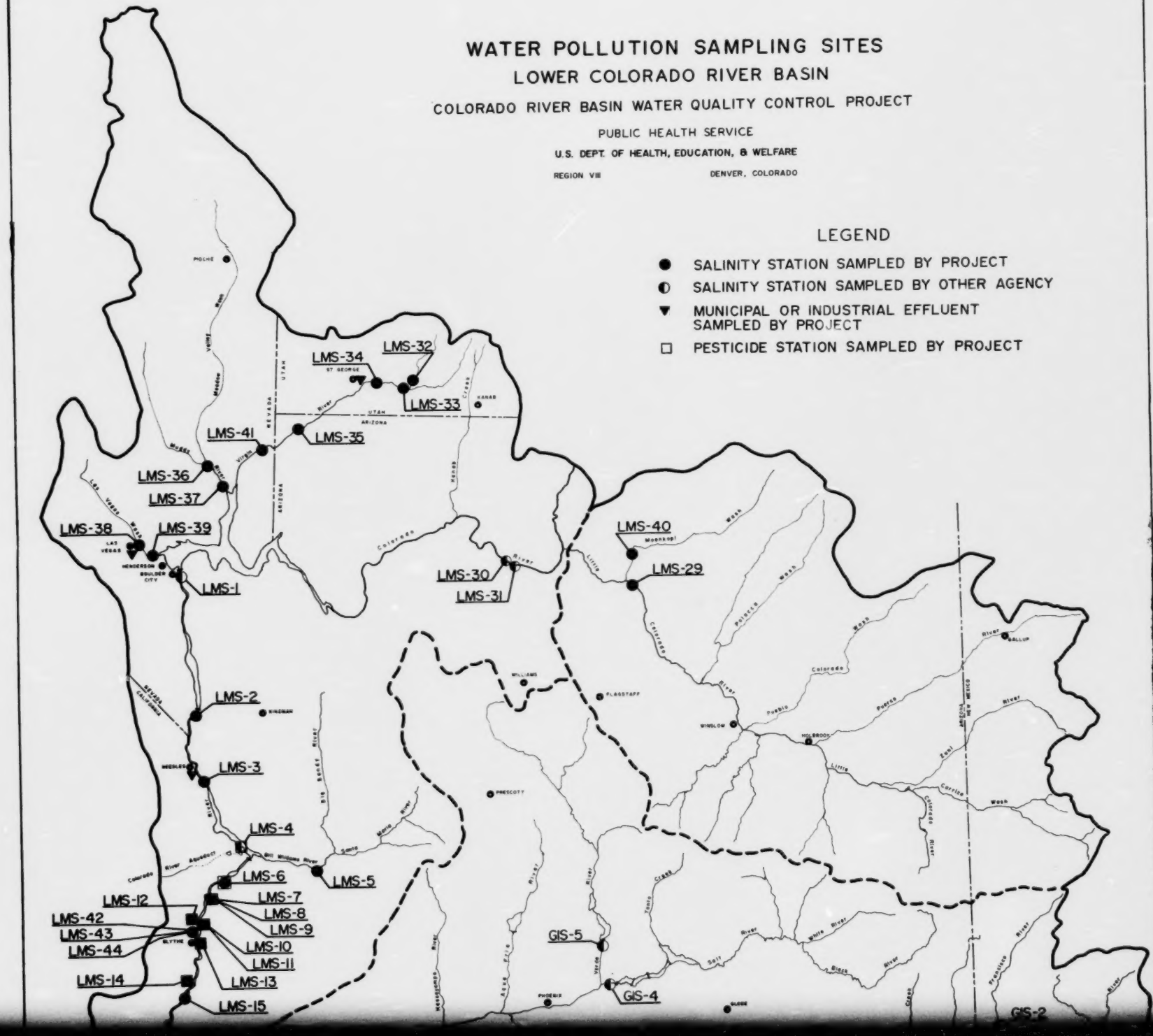
## LOWER COLORADO RIVER BASIN

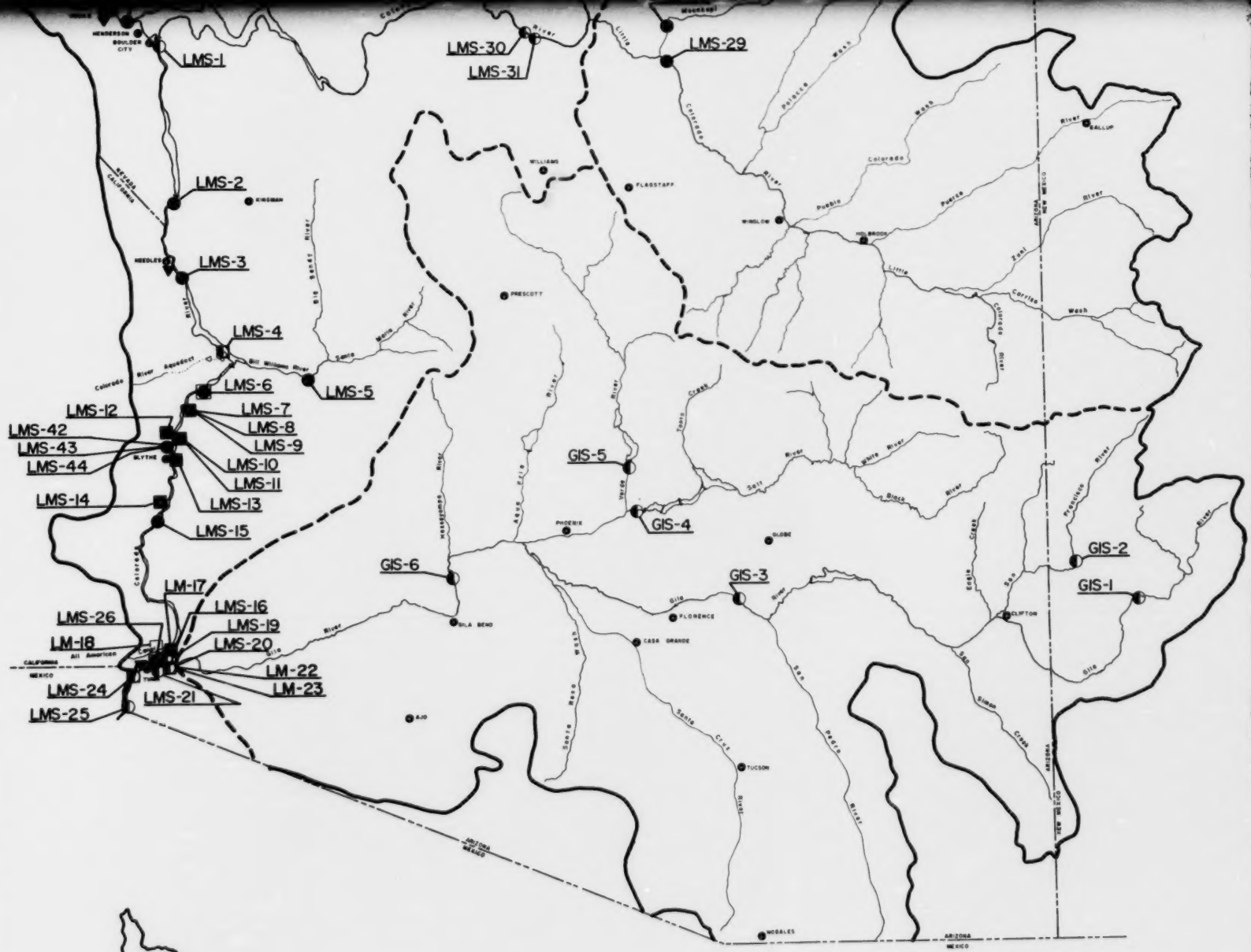
COLORADO RIVER BASIN WATER QUALITY CONTROL PROJECT

PUBLIC HEALTH SERVICE

U.S. DEPT. OF HEALTH, EDUCATION, & WELFARE

REGION VIII DENVER, COLORADO

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NEEDLES
BLYTHE
PRESCOTT
WILLIAMS
FLAGSTAFF
WINSLOW
HOLBROOK
GALLUP
PHOENIX
GLOBE
CASA GRANDE
FLORENCE
SAFFORD
CLIFTON
TUCSON
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AJO
YUMA
GILA BEND
Colorado River
Gila River
Little Colorado River
Bill Williams River
Santa Maria River
Big Sandy River
Aqua Fria River
Agua Fria River
Hassayampa River
Verde River
Salt River
White River
Black River
San Pedro River
Santa Cruz River
Rio Grande
Pecos River
Puerco River
Zuni River
Chevelo Creek
Eagle Creek
San Simon Creek
Dinnebito Wash
Polacca Wash
Canyon Wash
Santa Rosa Wash
Aqueduct
All American Canal
ARIZONA
NEW MEXICO
CALIFORNIA
MEXICO
ARIZONA
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LOWER MAIN STEM
SAN JUAN
GILA
MAJOR SUB-BASINS
0 10 30 50
SCALE IN MILES

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Special Techniques

The Project has employed special techniques in several areas to accomplish immediate and long term objectives. Of paramount importance has been the development or adaptation of analytical techniques for radiochemical elements in water. The Laboratory Radiochemical Unit has developed universally accepted improved techniques for measuring radium-226 in water. It has developed sensitive techniques for lead-210, polonium 210 and thorium, as well as strontium-90. The Laboratory and its director are used as a "referee" and training facility by industry, States, other Federal agencies, and international elements. Mr. Rushing and his staff are a rare and valuable resource.

In the development of a program for ultimate control of uranium mill tailings piles, the Radiological Section is using aerial survey techniques to help define the problem and to get a reasonable quantitative estimate of pile size and volume. This will obviate extensive stadia surveys which are time-consuming and expensive.

In a river basin comprising some 200,000 square miles, the logistics of a sampling program require special consideration. This is particularly true in relatively inaccessible locations where conductivity meters are used. The use of this type of device reduces the amount of manual sampling required. Because of fouling and other maintenance problems, meters adapted especially for the Project have been developed. In addition to the non-clogging feature of the cell unit, the meters will provide a continuous record for 28 days. Conductivity versus chemical constituent relationships will be determined from chemical analyses of samples collected at the time of routine meter servicing.

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All historical quality data from both published and unpublished records for the principal streams in each of the sub-basins have been compiled and studied. From these long-term records, data have been selected which are considered to be appropriate, representative, and reliable for statistical studies. These data are analyzed by statistical methods to determine the pattern of increases or decreases in salinity concentrations and loadings in relation to time and distance.

The time pattern is analyzed in relation to the history of water use and other developments, such as the impoundment of major reservoirs, establishment of irrigation projects, and exportation of water from the basin. Analysis of variance is used for comparison of categorical variance with the pooled or universe variance. The distance pattern is analyzed with the view of identifying reaches of streams where significant salinity build-up occurs. In the distance studies, the student's "t" test is employed for comparing data for sequential pairs of stations.

DEPARTURE FROM 1965 PLANS

During the past year the one characteristic which can describe the Colorado River Basin Project is -- change. This is perhaps best reflected in the staff changes during this period. A change in Project Director, Deputy Project Director, Field Station Chief, and the acquisition of a Chief of the Pollution Control Section were the most significant examples. Actually, a total of 13 new faces were added to the Project. On the other hand, three staff members in the Biology and Organics Laboratory Sections were transferred or took positions in sister agencies in the Government; three others of the Denver staff were reassigned to positions in the Division; while normal attrition claimed four people through resignations. This reflected a net personnel increase to the FY 1965 Project program of six people.

Recruitment problems were signficant. The Project lost an excellent prospect for the staff economist position due in large part to the lengthy time required to classify his grade. Personnel freezes were constant companions to the Project. Starting in September, the Project's recruiting efforts were hamstrung by successive personnel ceilings imposed as the result of section 206 of the 1965 DHEW Appropriations Act, the Division Civil Service freeze in January and the Commissioned Officer freeze in February. Despite these formidable obstacles, the Project was successful in bringing on duty four engineers and a staff economist during this period.

Project plans were altered considerably. A terminal date for the submission of the Project final report on salinity pollution was set for December 31, 1966. This tight schedule is subject to modification due to delays such as described later in this section.

A decision was made to concentrate damage evaluation by the Pollution Control Benefits Section on those existing and potential water-use areas of greatest impact, specifically -- southern California, southern Nevada, and central Arizona. An immediate shift to evaluate damages to southern California - the area of greatest potential - was made early in the fiscal year. This necessitated deferring completion of the assessment program for the Lower Main Stem, which is 75 percent complete.

The Pollution Control Section modified its program to operate throughout the Basin without regard to sub-basin boundaries. Specifically, the section is concentrating effort on those significant natural sources of saline pollution having feasible control potential.

The acceleration of the overall Project program and the decision to concentrate on the interstate waters of the Colorado River and its tributaries effected dramatic changes in field activities. The Gila and Little Colorado River Sub-Basins are primarily intrastate systems, neither contributing significant flows to the Colorado River Main Stem from the major portions of the respective sub-basins. No major field sampling operations are now scheduled for either of these basins.

The field activities are currently operating in the entire Upper Basin instead of on a sub-basin by sub-basin basis as originally planned. Field work is now planned to be completed by December 1965.

Equipment delays have plagued the Project field program. Ten conductivity meters ordered from the Industrial Instruments Company, Cedar Grove, New Jersey, in June 1963 were received during June 1964. Field checks revealed major problems due to malfunctions and design characteristics in

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the units which could not be reconciled. The equipment was returned to the manufacturer, who has since made extensive adjustments and modifications to the equipment. The units are currently being laboratory tested by Project and SEC personnel.

With the emphasis in field operations shifted to the Upper Basin, the decision was made to assign field personnel to a Depot in Grand Junction, Colorado. This has been accomplished.

The hypothesis proposed by the Economic Contractor as the end-point analysis merging engineering and economic components through adjustment of gross regional product net of water cost was modified. The analyses as presently conceived would be a series of alternative programs involving: a) benefit-cost analyses of pollution sources which can be feasibly controlled within the Colorado River Basin, b) benefits-cost analyses with respect to alternative degrees of treatment of supplies to major water users, and c) the incremental benefits which can be assessed to quality improvement of the Colorado River due to water imported into the Basin.

The passage of the 1965 DHEW Appropriations Act produced unforeseen demands on staff time. The restrictions imposed by section 206 of that Act required essential shut-down of Project field and analytical operations having any bearing on salinity or irrigation water quality during September and October. A major effort by the Project staff was required during the period from September through December to satisfy the needs of the President's Science Advisory Committee.

PLANS AND SCHEDULES FOR FY 1966

Activities and Accomplishments

The Project schedule for FY 1966 reflects progress. Field work in the Basin will be completed; damages assessed for the major Colorado River water use areas; preliminary feasible control programs for significant pollution sources will be developed; the merging of the engineering-economic factors will be underway; and the final report will be in preparation. Briefly, the activities of the various sections can be described as follows:

Pollution Control Benefits Section - During the first half of fiscal year 1966 we expect to complete the calculation of present and future economic effects of salinity and hardness in the southern California water service area, and to begin the evaluation of benefits of proposed salinity control measures both in that area and in the Lower Main Stem Sub- Basin of the Colorado River. The latter work will be done in cooperation with the Pollution Control Section. We shall also develop water quality bases for the salinity damage assessment in the Gila Basin and in the three sub-basins of the river above Lee Ferry, commencing about November 1965. During the second half of fiscal year 1966 field data surveys will be carried out in the Upper Colorado River Basins. Estimates will be made of salinity effects in the Gila Basin consequent upon the interstate importation of water by the Central Arizona Project.

Pollution Control Section - Preliminary plans for feasible methods of control for all significant salinity sources will be prepared and completed by the end of FY 1966. Significant inroads in the preparation of definite plans will be made for the most important sources of pollution and those sources, if not the most

significant, for which the most feasible methods of control are possible. Reports on the effects of phreatophytes and other natural consumptive elements as well as evaporation and out-of-basin diversions will be prepared during FY 1966.

The reduction in concentration of salinity and the control cost figures for the various pollution sources and/or treatment methods developed during the coming year will provide an essential input to the engineering-economic analyses, which are basic to the development of recommendations for the alternative programs for water quality control in the Basin.

Field Studies and Evaluation Section - All field activities in the Green, San Juan, and Upper Main Stem Sub-Basins will be completed during the first half of FY 1966. The Grand Junction depot will be phased out with certain professional and technical personnel transferred to Project headquarters in Denver, Colorado at the end of December 1965. The second half of the fiscal year will be devoted primarily to final analysis and evaluation of data collected in the Upper Colorado River Basin and the preparation of preliminary reports covering field station activities.

Radiological Surveillance Section - Fiscal Year 1966 Radiological Surveillance activities will be essentially identical to FY 1965, with continuation of the water, sediment, and effluent surveillance programs. Further investigations into the effect of abandoned uranium mill tailings piles on stream quality, both radiological and chemical, may be necessary, depending upon the conclusions derived from current investigations. Stream biota and crop studies will have been completed. Surveillance data will be transferred to the STORET system. Manpower requirements will remain the same.

Laboratory Services Section - The radiological unit of the Laboratory will continue on the same basis as in FY 1965. The inorganic unit will essentially complete its role with the analysis of final samples from field studies scheduled for late spring of 1966.

Economic Studies - The economic contractor, the University of New Mexico, will require an extension of contract time to June 30, 1966, in order to meet the Project objectives. An analysis of the effect of water quality as a constraint to the Regional economy will be made. An end point analysis requisite to the development of recommendations to the conferees will be made in cooperation with the Project staff. The agricultural segment of the economic study will require further work by the Economic Research Service, USDA, Logan, Utah. The economics section of the Project final report will be underway.

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Economic Studies

The economic study is being conducted by the University of New Mexico in collaboration with the University of Colorado. The demographic portions of the economic study have been conducted by a demographer at San Diego State College. The Public Health Service has negotiated a separate agreement with the U. S. Department of Agriculture providing for all components of the study relating to agriculture and forestry.

Virtually all of the field work on the nonagricultural aspects of the economic study was completed during the first half of the current fiscal year. Work on the input-output tables has progressed according to schedule, and it is anticipated that the integrated and reconciled sub-basin tables will be completed by the end of the current fiscal year.

Concurrently with the construction of the sub-basin input-output tables, the economic contractors have been gathering data on water-use for each of the sectors. It is anticipated that water-use coefficients for all of the non-agricultural sectors will be computed before the end of the current fiscal year. Depending upon the availability of data, it is also hoped that such coefficients can be computed for the agricultural sectors.

Work is also currently underway on the revision of all projections of final demand to 1980 and 2010. At the same time, progress is being made on the projection of technical coefficients for the three lower sub-basin tables, and the technical coefficients for all six sub-basins will have been projected by the end of the current fiscal year. The two sets of projections, those of final demand and of the technical coefficients, will serve as the basis for the projection of interindustry transactions in 1980 and 2010. Water-use coefficients will then be integrated with the input-output model

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to provide projections of water demand in the two target years. In making these projections, a water quantity constraint will be taken into account; that is, it will be assumed that the present allocation of water by sub-basin will remain unchanged through 2010.

A dynamic model for projecting the interindustry transactions, and patterns of water-use, to 1980 and 2010 have been developed. The method to be employed, together with a set of illustrative projections, is described in an interim report, Illustrative Inter-Industry Projections of the Lower Sub-Basin Economies to 1965, 1980 and 2010, prepared by William H. Miernyk, Acting Project Director of the economic study, and submitted to PHS on November 23, 1964. This report describes the way in which the technical coefficients will be projected, as well as the methods used in projecting final demand sector by sector. In conjunction with the long-range projections, a series of industrial location studies are being conducted by the University of New Mexico in an effort to anticipate the kinds of economic activity which might be represented in the Colorado River Basin in 1980 and 2010, but which were not in the Basin in 1960. Engineering-type technical coefficients will be developed for any activities of this kind and these will be inserted in the projected input-output tables. Changing interregional trade patterns will also be taken into account in making the long-range projections. Use of the dynamic model will obviate one of the criticisms that has been made against input-output projections in the past, namely that they are based on fixed technical coefficients. It is anticipated that this method will give far more realistic projections of the levels of economic activity in each of the sub-basins in the target years as well as the consumptive use of water in each of the sectors in those years.

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Work is also continuing on the development of an optimizing model which will help bridge the gap between engineering and economic studies. It is not anticipated that this part of the study will be completed during the current fiscal year.

Present plans call for the completion of all analytical work on the input-output tables, the long-run projections of population and labor force, and the projections of interindustry transactions by the end of the current fiscal year. Further time will also be required for the preparation of a final report. It is now anticipated that this report can be completed by June of 1966.

The Project staff have collaborated in several ways in furthering the Economic Contractor's work. In August 1964 a preliminary study and report entitled "Water Quality Demands for Major Manufacturing Groups in the Colorado River Basin" were completed. In that report estimates were developed for the total intake water requirements in 1965, 1980, and 2010 in six types of manufacturing industries in the Basin. In addition data were compiled on the percentages of industrial water intake which are consumed and recirculated. The estimates of water demand were based on illustrative projections of industrial activities which were furnished by the Economic Contractor in December 1963.

In January 1965 the Project staff completed a second report entitled "A Study of Municipal, Rural Domestic and Livestock Water Requirements in the Colorado River Basin." In this report estimates are made of the water requirements for the stated uses in 1965, 1980, and 2010. These estimates are based upon projections of population growth and of livestock production furnished by the Economic Contractor and the Economic Research Service of the Department of Agriculture.

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The Project has done considerable research in the area of agricultural water demand, and has available for the Economic Contractor's use much data on gross farm delivery and leaching water requirements, consumptive use by crops and by areas, and other relevant statistics. Most of the work done by the Project staff in the latter categories pertains to the Lower Basin.

In December 1964 an arrangement was made with the Economic Contractor whereby the Project will provide advisory service in developing water use coefficients which will enable the Contractor to convert projections of economic activities expressed in dollar values, to intake water requirements for the major industries in the Basin.

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PESTICIDES--AN INTERSTATE PROBLEM?

At the Fifth Session of the Conference, a request was made to report on interstate aspects of possible pesticide pollution of the Colorado River and its tributaries. The Project approached this particular assignment by analyzing existing data collected by it and by the National Water Pollution Control Monitoring Network; through consultation with SEC scientists; and through contact with other Federal agencies having responsibilities in this area such as the Bureau of Sports Fisheries and Wilflife, Fish and Wildlife Service, Department of the Interior.

The available water quality data did not give sufficient information to provide a reasonable evaluation of the problem. Conferences were held with Dr. W. M. Ingram, In Charge--Biological and Chemical Activities, Technical Advisory and Investigations Section, SEC, to help define the program. Essentially, the upshot of these meetings was the development of a field reconnaissance of the interstate waters of the Colorado River by a team of biologists and engineers from SEC and the Project. The purpose of these field evaluations was to determine the logical sampling areas in the event of an incipient or actual pollution by pesticides. The recommended sampling program in the event of such an occurrence is outlined in the report following this statement.

The analysis for pesticides in water provides only one part of the picture. At any one station the experts consider it important to make analyses on sediments, benthic organisms, fish, and possibly plankton in order to make a meaningful evaluation. These sample requirements raise the very valid point of competent laboratory capacity. Our experts state that many of these analyses are in the order of individual research projects.

Routine standardized analytical techniques, when available, are limited to specific compounds known to be present in the sample. The Bureau of Sports Fisheries and Wildlife Laboratory at the Denver Federal Center uses this methodology in their experimental work with fish and wildlife.

Specific problems exist with respect to referencing any sample with the inputs of pesticides to the watershed above the sample point. Knowledge is needed on how much pesticide has been applied in a particular watershed, when the pesticide was applied, where in the watershed the pesticide was applied, and the breakdown as to types of pesticides. These types would be grouped as either organic phosphates, chlorinated hydrocarbons, or carbonates. The data would have to be compiled on a continuing basis in order to be useful. Information of this type is now being provided to the Bureau of Sports Fisheries and Wildlife by all Federal Governmental agencies within the Colorado River Basin. Recently, it was reported that the U. S. Department of Agriculture has made tentative arrangements to collect similar information through the local agricultural agents. A suggestion has also been made that the Bureau of Reclamation could obtain this information through its operating divisions for the various irrigation projects in the Basin. However, the collection of this type of data by a single agency would be very difficult. Each State has a definite responsibility in this area and should be willing to coordinate the assembly of such information within its boundaries. A letter to this effect has been sent to each conferee within the past month.

Whether a problem actually exists may be inferred from past experience. To assess this possibility, a history of fish kills during the past fifteen years in the interstate waters of the Colorado River would be useful. In each instance an evaluation should have been made by the responsible State

agency as to what the specific causes of the kills were; i.e., municipal, industrial, agricultural, or natural. A request for this information was included in the letter sent to each conferee.

A further concern is the collection of samples. As indicated in the following report on sample requirements, a certain degree of competence is required to collect meaningful samples, whether they be water, sediment, bottom organism, or fish. The most promising possibility is the use of Fish and Wildlife personnel having biology experience. According to Mr. Croswell Henderson, Chief of the Bureau of Sports Fisheries and Wildlife Pesticides Surveillance Unit, most of their people with this background are being trained to collect such samples. These people are located throughout the Basin and would be available should the need arise. Very likely, people with similar backgrounds in State agency service might be available for assistance. In a conference with Mr. Henderson and Dr. Oliver Cope, Director of the Bureau of Sports Fisheries and Wildlife laboratories at the Denver Federal Center, these gentlemen indicated a willingness to work cooperatively with the Project and that a portion of any samples collected during a pollution incident might be analyzed at that facility. This cooperation presupposes knowledge of the type and quantity of pesticides applied to the upstream watershed.

Specific areas which appear to have a pesticide pollution potential at the present time include the Lower Colorado River below Parker Dam, the Colorado River in the Grand Junction, Colorado area, and the lower reach of the Uncompahgre River. Further contact with State agencies having responsibilities in these areas is necessary. Dr. Cope indicated a willingness to cooperate in providing analytical capability should a field evaluation be indicated. The reactions of the Conferees involved and the availability of technical personnel

from Federal and State agencies would dictate what action should be taken. Mr. Henderson indicated that a series of fish kills have occurred in the Lower Colorado River stretch in particular over the past several years.

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THE INVESTIGATION OF PESTICIDES
AS RELATED TO FUTURE FISH DEATHS
IN THE COLORADO RIVER BASIN

A meeting to consider the relationship of pesticides to possible future fish deaths at interstate boundaries in the Colorado River Basin was attended by Messrs. J. M. Rademacher and J. W. Fitzpatrick, Colorado River Basin Project, and Dr. William M. Ingram and Mr. Nelson Thomas, Technical Advisory and Investigations Section, on September 21, 1964. The decision was reached that without adequate knowledge of pesticidal threshold levels, sampling should not be conducted prior to a fish mortality. If fish deaths should occur in the Colorado River Basin, and pesticides are suspected, samples then should be collected in the fish mortality area.

Information on types and quantities of pesticides used in the Colorado River Basin along with information on previous fish mortalities were to have been requested from the States by project personnel. This information is not now available to the Public Health Service. Such information will allow the identification of potential critical areas where future fish deaths might be expected to occur, and will permit more intensive observation and coordination of reporting among the interested agencies.

To accomplish efficient reporting, arrangements should be made to instruct persons who have daily contact with the river to call the Colorado

River Basin Project Director or Deputy Project Director in the event of a fish mortality. The Project Director or his Deputy will, after assuring himself that a fish mortality of sufficient magnitude to warrant sampling has occurred, notify appropriate State agencies of the stations to be sampled.

Stations at State line areas at which various types of samples (indicated by an asterisk) may be collected for pesticidal analyses are as follows:

| Station | Types of Samples Possible | | | |
|---|---|---|---|---|
| | Fish | Water | Bottom Organisms | Sediment |
| 1. Green River (Green River, Wyo.) Rt. 530 Bridge | * - | * - | * - | |
| 2. Black's Fork, Green River, Wyo. Hy. 30 Bridge | | * - | * - | * - |
| 3. Henry's Fork near Linwood, Wyo., Co. Rd. 4-13 1 1/2 mile above 530 | | * - | * - | |
| 4. Green River below Flaming Gorge Dam, Utah, Power House Rd. | * - | * - | * - | |
| 5. Green River at Ouray, Utah Above White & Duchesne Rivers | * - | * - | | |
| 6. Duchesne River at Randlett, Utah, Hy. 88 | * - | * - | * - | * - |
| 7. Green River at Jensen, Utah Hy. 40 | * - | * - | | |
| 8. Little Snake at Lily, Colo. 6 miles off Hy. 40 | | * - | | |
| 9. Yampa River at Lily, Colo. 6 miles off Hy. 40 | * - | * - | * - | * - |
| 10. White River at Rangely, Colo. Hy. 64 Bridge | * - | * - | * - | |

FOR DISCUSSION ONLY



| Station | Types of Samples Possible | | | |
|---|---|---|---|---|
| | Fish | Water | Bottom Organisms | Sediment |
| 11. Green River at Green River, Utah, Hy. 50, 6 | * | * | * | * |
| 12. Colorado River at Fruita, Colo., Hy. 340 | * | * | * | * |
| 13. Colorado River at Moab, Utah, Hy. 160 | * | * | | * |
| 14. Dolores River at Gateway, Colo., Hy. 141 | * | * | * | * |
| 15. McElmo Cr. at Cortez, Colo., Hy. 666 | | * | | |
| 16. Mancos Cr., Cortez-Shiprock, N. M., Hy. 666 | | * | | |
| 17. San Juan River, Shiprock, N. M., Hy. 666 | * | * | * | * |
| 18. La Plata River at Farmington, N. M., Hy. 550 | | * | | |
| 19. Animas River at Bondad, Colo. Hy. 550 | * | * | * | |
| 20. San Juan River at Blanco, N. M., Hy. 17 | * | * | * | * |
| 21. La Pinos River at Ignacio, Colo., Hy. 172 | * | * | * | |
| 22. Piedra, 6 miles N. Allison, Colo., Hy. 151 Bridge | * | * | * | |
| 23. San Juan River near Carracas, N.M., Co. Rd. - 1/2 mile above confluence | * | * | * | * |
| 24. Colorado River at Page, Ariz. Hy. 89 | * | * | | |
| 25. Virgin River at Bloomington, Utah | | * | | |

| Station | Types of Samples Possible | | | |
|---|---|---|---|---|
| | Fish | Water | Bottom Organisms | Sediment |
| 26. Virgin River at Littlefield, Ariz., Hy. 91 | | * | | |
| 27. Meadow Valley Wash Muddy River at Logandale, Nev., Hy. 12 | | * | | |
| 28. Overton Arm of Lake Mead, Nev. | * | * | | |
| 29. Las Vegas Wash, Nev. | | * | | |
| 30. Willow Beach (trout from Hatchery) | * | * | | |
| 31. Colorado River, Willow Beach | * | * | * | |
| 32. Colorado River between Parker Dam & Parker, Ariz. Hy. 172 | * | * | * | * |
| 33. Colorado River at Blythe, Calif., Hy. 95 | * | * | * | * |
| 34. Colorado River above Imperial Dam | * | * | * | * |
| 35. Four return drains from Colo. River Indian Reservation, Ariz. | * | * | * | * |
| 36. Palo Verde Drain | * | * | * | * |
| 37. Mohawk-Wellton Drain | * | * | * | * |

In the event of a fish mortality where pesticides are suspected the following sampling methods and sample shipment should be employed. Containers

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must be of glass and must be thoroughly cleansed with a reagent grade organic solvent, e.g., hexane or acetone, and allowed to dry.

Fish : Obtain 10 of each species at a control station, and at all stations within the fish mortality area. Obtain blood and save fish carcasses.

Blood : (1) Dry the exterior of the fish.

(2) Cut off the caudal penduncle just posterior to the anus.

(3) Hold in a vertical position, head up, and allow blood to collect in a 10 to 12 cc glass vial to one-half of the vial's capacity.

(4) Cover vial top with aluminum foil then secure cap and freeze immediately.

(5) Code blood sample to carcass.

Carcass : (1) Place in plastic bag and freeze.

Water : Either use containers available from PHS or use 1 quart glass bottles, filling with water to within one-half inch of top. Cover top with aluminum foil and secure lid. Do not freeze water samples, ship immediately.

Sediments : (1) Collect 50 to 150 grams of sample in 1 quart glass jar, using only the top 1/2 inch of bottom deposits.

(2) Cover top with aluminum foil, secure lid, do not freeze, ship immediately.

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Bottom Organisms: (1) Fill a 10 or 20 cc vial to one-half capacity with specimens, cover top with aluminum foil, secure cap, and freeze.

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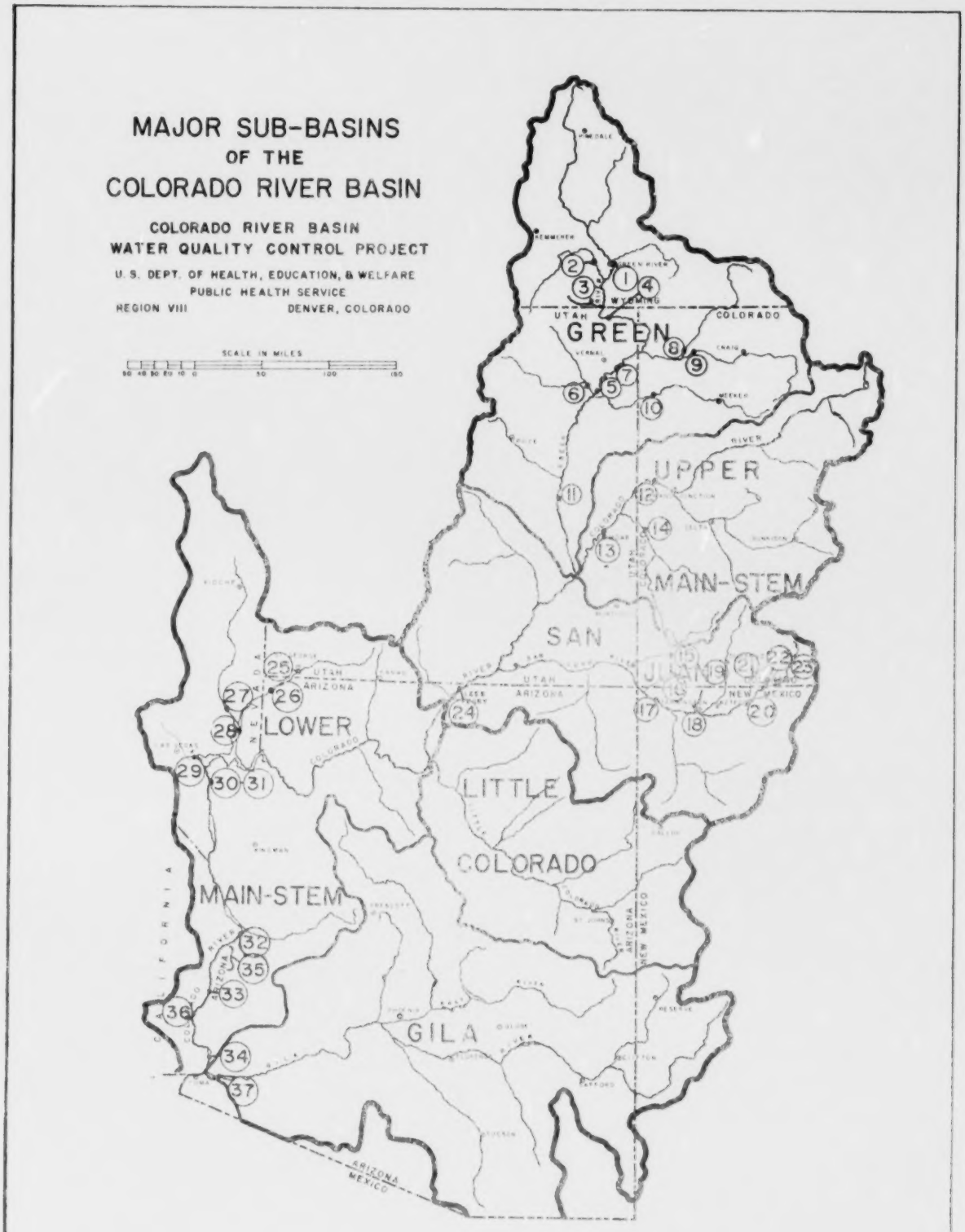



SELECTED STATIONS FOR PESTICIDAL SAMPLING

FOR DISCUSSION ONLY



## LAKE MEAD INVESTIGATIONS

Certain questions have been raised about the quality characteristics in Lake Mead by another Federal agency. These were particularly referenced to the bacteriological and biological quality in this body of water as it affected recreational uses of the lake. Mr. W. W. White, Project personnel, and Sanitary Engineering Center scientists are now developing a cooperative investigation and surveillance program to clarify any question by the public or other responsible agency. Mr. White has indicated a desire to discuss this particular program at the Technical Session.

# APPENDIX "A"

(INTENTIONALLY LEFT OUT)

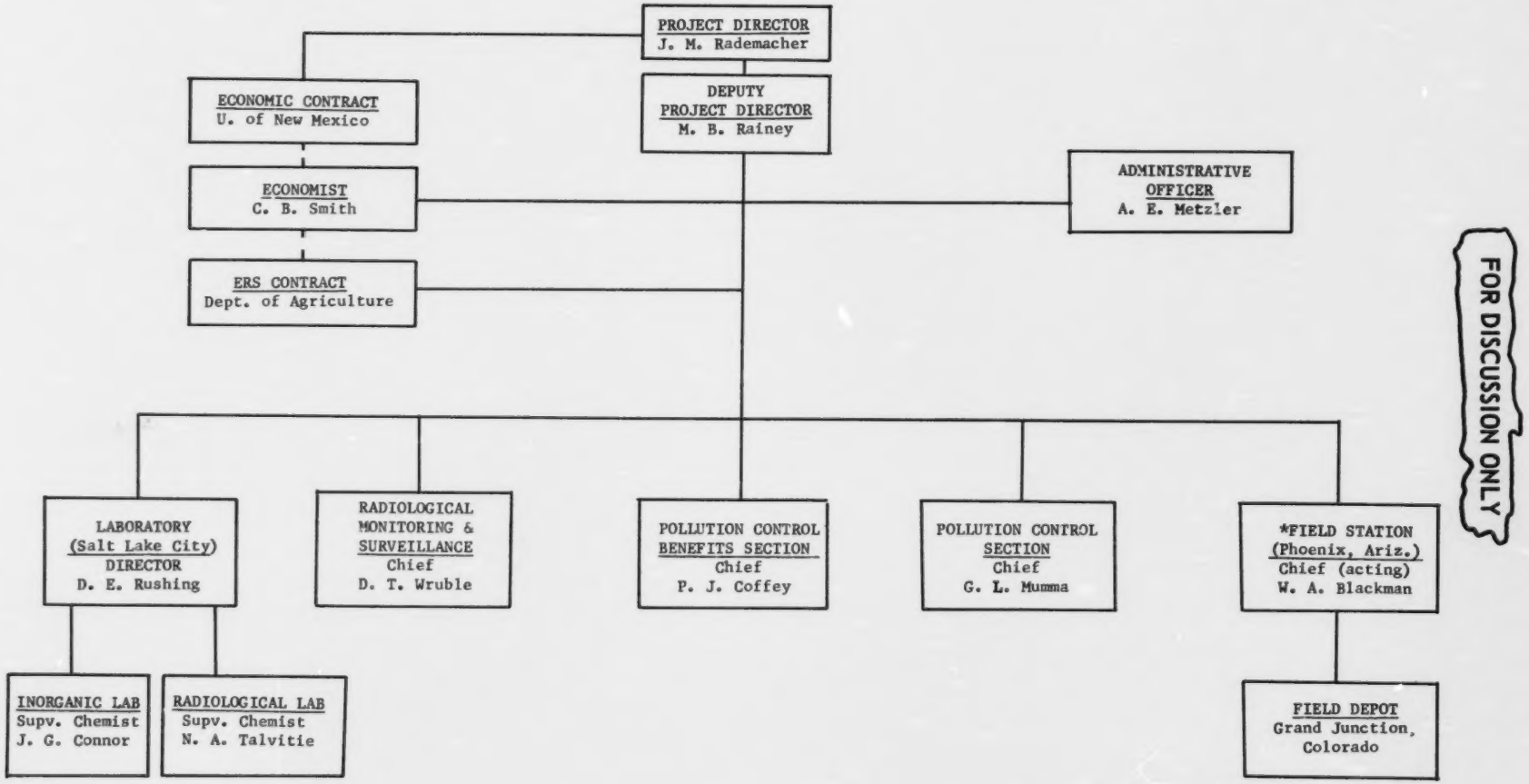
# APPENDIX "B"

March 1, 1965

# ORGANIZATION CHART

Region VIII, Denver, Colorado

COLORADO RIVER BASIN PROJECT




FOR DISCUSSION ONLY

*Field Station at Phoenix to be closed 6/30/65. Personnel to transfer to Denver and unit will operate as Field Data Evaluation Section.

10C-1

FOR DISCUSSION ONLY

## PROJECT PERT DIAGRAM

Please refer to the large folded chart in the special pocket immediately preceding the back cover of this booklet.

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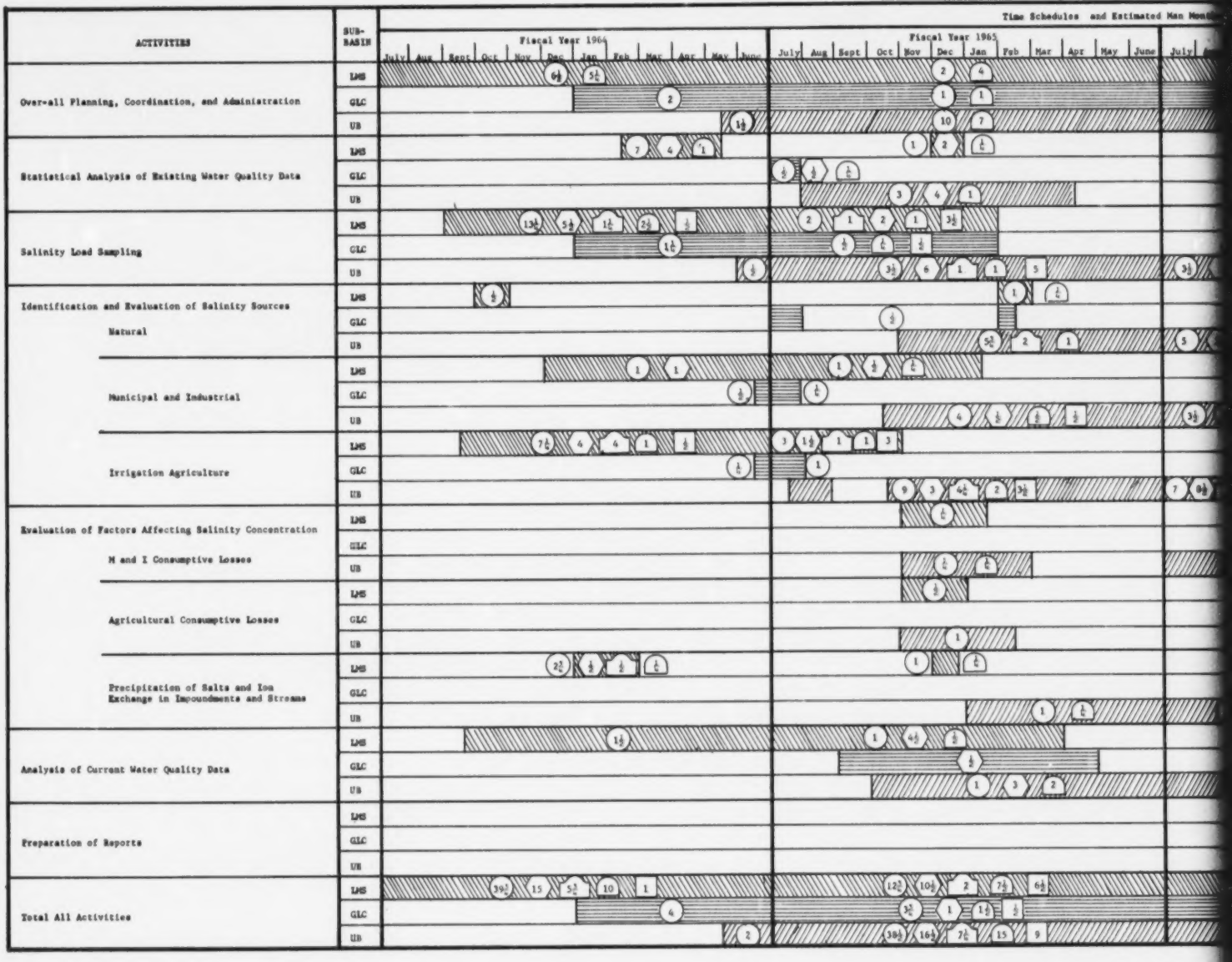
FOR DISCUSSION ONLY

RADIOLOGICAL SURVEILLANCE PERT DIAGRAM

Please refer to the large folded chart in the special pocket immediately preceding the back cover of this booklet.

# WORK PROGRA
## FISCAL YEARS 19
## FIELD STATI
## COLORADO RIVER BASIN WATER C


Time Schedules and Estimated Man Months
Fiscal Year 1964
July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June
Fiscal Year 1965
July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June July
ACTIVITIES
SUB-BASIN
Over-all Planning, Coordination, and Administration
Statistical Analysis of Existing Water Quality Data
Salinity Load Sampling
Identification and Evaluation of Salinity Sources
Natural
Municipal and Industrial
Irrigation Agriculture
Evaluation of Factors Affecting Salinity Concentration
M and I Consumptive Losses
Agricultural Consumptive Losses
Precipitation of Salts and Ion Exchange in Impoundments and Streams
Analysis of Current Water Quality Data
Preparation of Reports
Total All Activities
LMS
GLC
UB

LEGEND

Sub-Basins

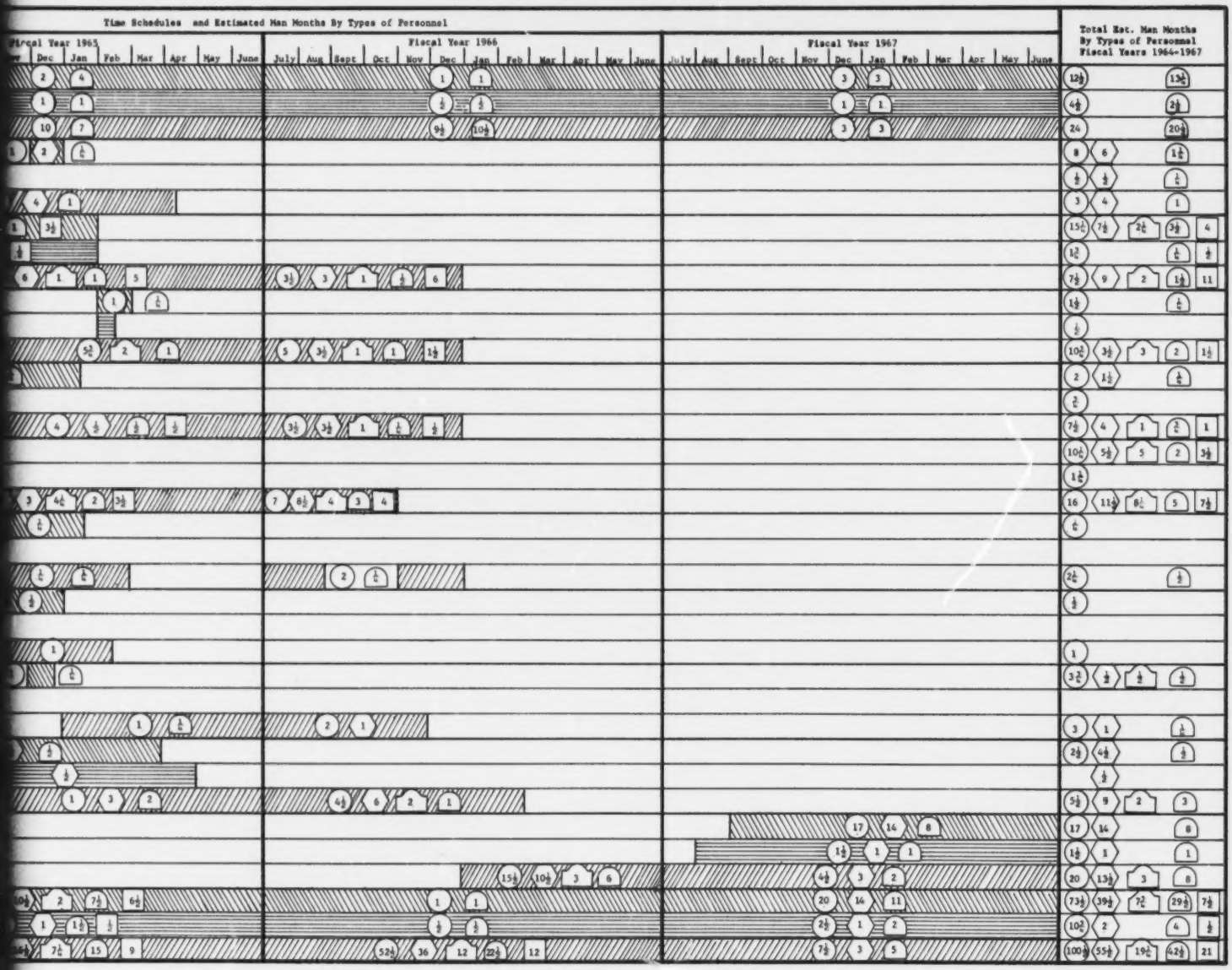
| | |
|---|---|
| LMS | Lower Main Stem |
| GLC | Gila & Little Colorado |
| UB | Upper Basin |

Est. Man

Note: Upper Basin Includes Green, Upper Main Stem, and San Juan Sub-Basins

# WORK PROGRAMING
## FISCAL YEARS 1964-1967
## FIELD STATION
## RADO RIVER BASIN WATER QUALITY CONTROL PROJECT

FOR DISCUSSION ONLY.




LEGEND

Sub-Basins

| | |
|---|---|
| LMS | Lower Main Stem |
| GLC | Gila & Little Colorado |
| UB | Upper Basin |

Note: Upper Basin Includes Green, Upper Main Stem, and San Juan Sub-Basins

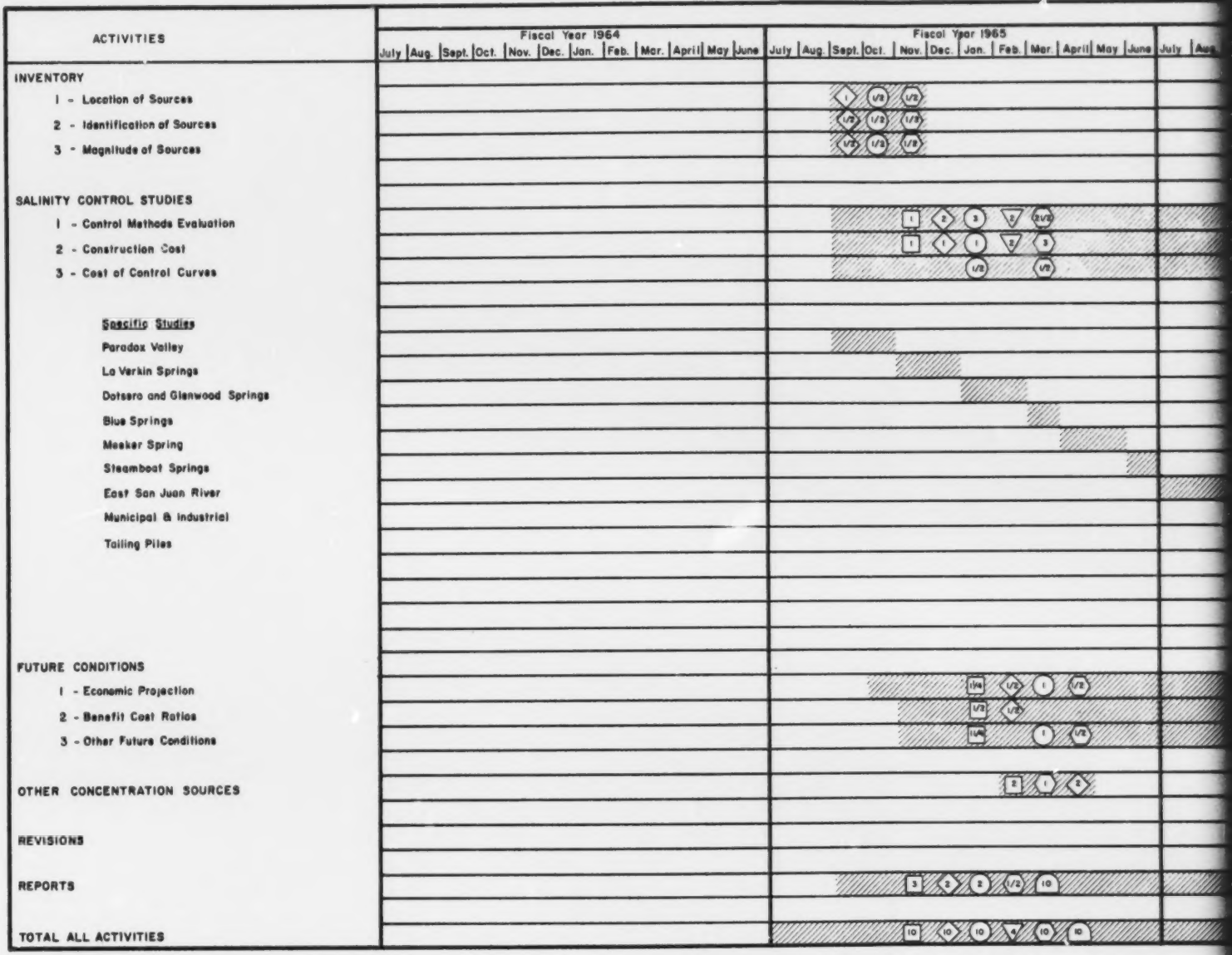
Est. Man Months By Types of Personnel

- Engineer
- Engineering Technician
- Laboratory Mechanic
- Aquatic Sampler
- Clerk-Stenographer

PFS 2/5/65

# WORK PROGRA

FISCAL YEARS 196
POLLUTION CONTROL S
COLORADO RIVER BASIN WATER QU




LEGEND

Estimated Man Month by Type

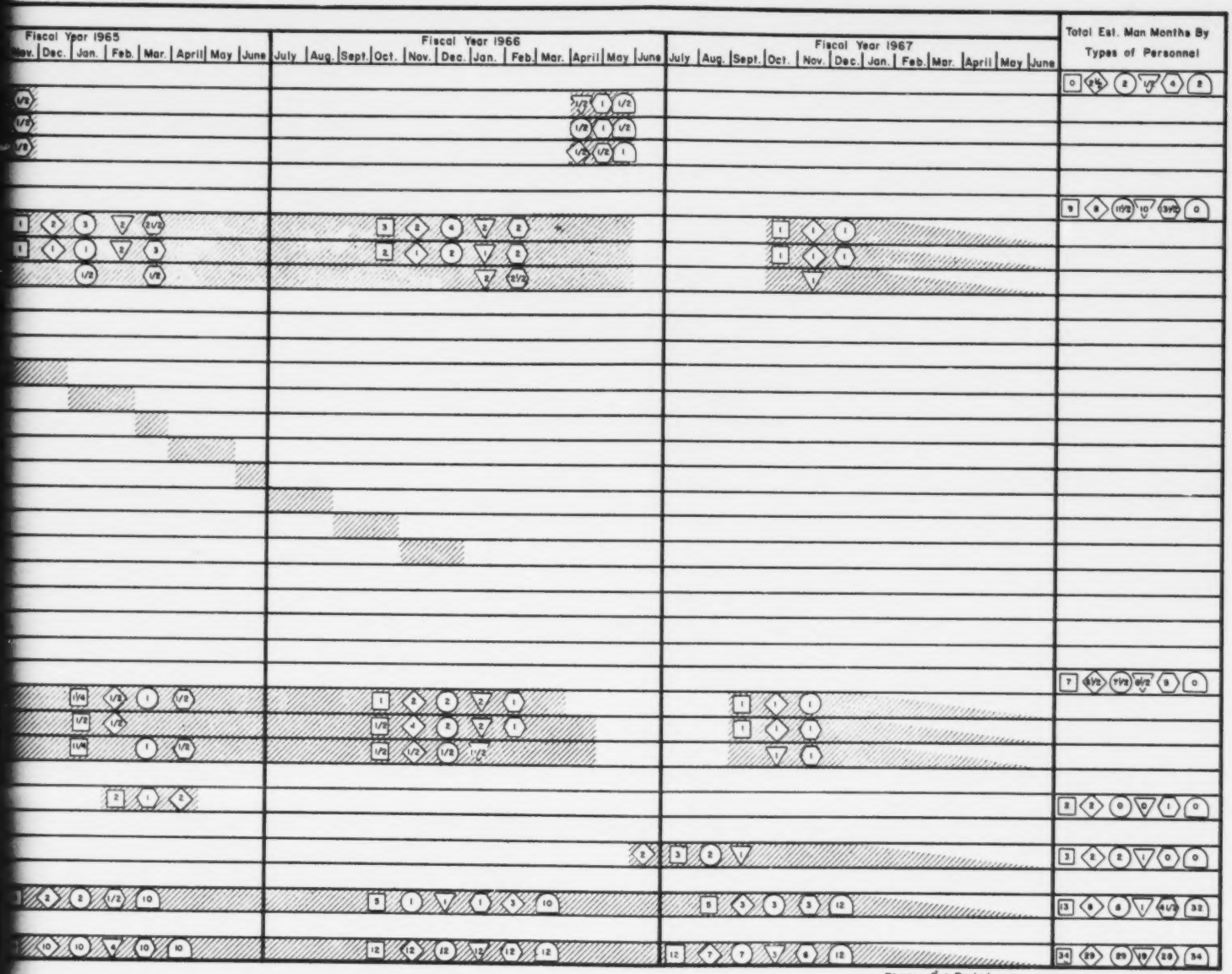
- Hydrologist
- Sanitary Engineer
- Geologist

# WORK PROGRAM

## FISCAL YEARS 1964 - 1967

## POLLUTION CONTROL SECTION

## RADO RIVER BASIN WATER QUALITY CONTROL PROJECT


Fiscal Year 1965
Nov. Dec. Jan. Feb. Mar. April May June
Fiscal Year 1966
July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. April May June
Fiscal Year 1967
July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. April May June
Total Est. Man Months By Types of Personnel
— Phase Out Period —

LEGEND

Estimated Man Month by Type of Personnel

- Hydrologist
- Sanitary Engineer
- Geologist
- Civil Engineer
- Technician
- Typist

# WORK PROG

## FISCAL YEARS
## POLLUTION CONTROL BE
## COLORADO RIVER BASIN WATER

| ACTIVITIES | WATER DEMAND AREA | Time Schedules and Estimated Man M<br>Fiscal Year 1964<br>July \| Aug \| Sept \| Oct \| Nov \| Dec \| Jan \| Feb \| Mar \| Apr \| May \| June | Fiscal Year 1965<br>July \| Aug \| Sept \| Oct \| Nov \| Dec \| Jan \| Feb \| Mar \| Apr \| May \| June \| July |
|---|---|---|---|
| 1 Basic Water Quality Studies | LMS | 8 24 | 2 ¼ |
| | SC | | 5 1 |
| | GLC | | |
| | UB | | |
| 2 Projections of Water Demand | LMS | 5 1½ | 2 ¼ 1 ¼ |
| | SC | | |
| | GLC | 1 | ¼ 1 ¼ 1 ¼ |
| | UB | | 1 ¼ 2 ¼ |
| 3 Projections of Water Quality | LMS | 6 1½ | 2 ¼ |
| | SC | | 3½ ¼ |
| | GLC | | |
| | UB | | |
| 4 Field Data Surveys | LMS | | ½ 0 ¼ 0 3 ¼ |
| | SC | | 7 1½ |
| | GLC | | |
| | UB | | |
| 5 Economics of Water Quality | LMS | 4 1 | 3 |
| | SC | | 6 1 |
| | GLC | | |
| | UB | | |
| 6 Estimation of Pollution Control Benefits | LMS | 1 ¼ 10 24 | 5 1 6 |
| | SC | | 5 1 7 1½ 2 ¼ ¼ |
| | GLC | | |
| | UB | | |
| 7 Evaluation of Effects of Pollution Control | LMS | | |
| | SC | | |
| | GLC | | |
| | UB | | |
| 8 Preparation of Reports | LMS | | 1½ ½ 1 0 2 ¼ |
| | SC | | 3 ½ |
| | GLC | | |
| | UB | | |
| Total All Activities | LMS | 33 8½ | 10 1½ 7½ 1 3 ¼ |
| | SC | | 38 7½ |
| | GLC | 1 | ¼ 1 ¼ 1 4 |
| | UB | | 1 ¼ 2 ¼ |

LEGEND

| Sub-Basins | | Est. Man |
|---|---|---|
| LMS | Lower Main Stem | |
| SC | Southern California | |
| GLC | Gila & Little Colorado | |
| UB | Upper Basin | |

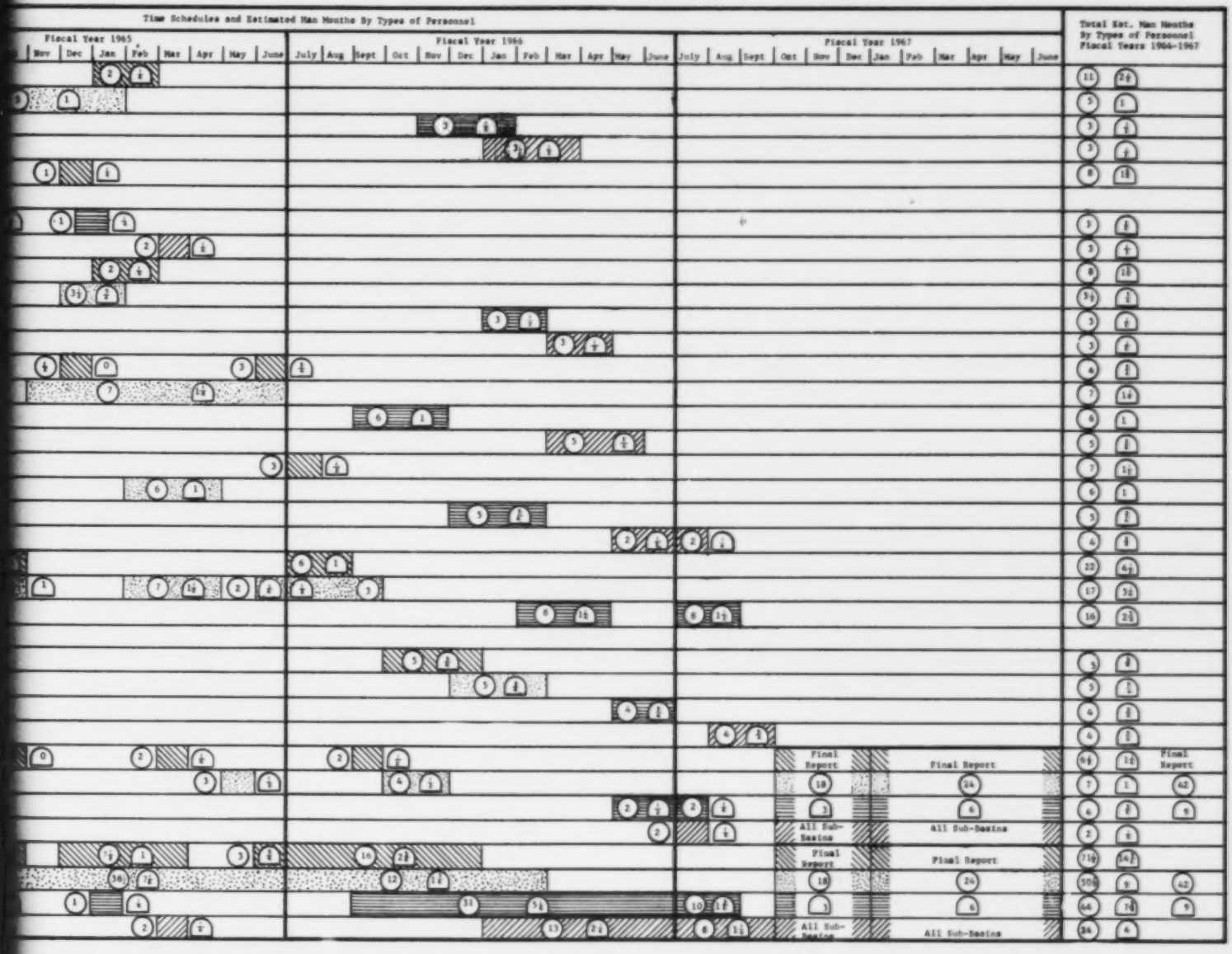
Note: Upper Basin Includes Green, Upper Main Stem, and San Juan Sub-Basins

# WORK PROGRAM

## FISCAL YEARS 1964 - 1967

## POLLUTION CONTROL BENEFITS SECTION

## LORADO RIVER BASIN WATER QUALITY CONTROL PROJECT


Time Schedules and Estimated Man Months By Types of Personnel
Fiscal Year 1965
Nov Dec Jan Feb Mar Apr May June
Fiscal Year 1966
July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June
Fiscal Year 1967
July Aug Sept Oct Nov Dec Jan Feb Mar Apr May June
Total Est. Man Months By Types of Personnel Fiscal Years 1964-1967
Final Report
All Sub-Basins
Final Report
All Sub-Basins
Final Report
All Sub-Basins
Final Report
All Sub-Basins
Final Report

LEGEND

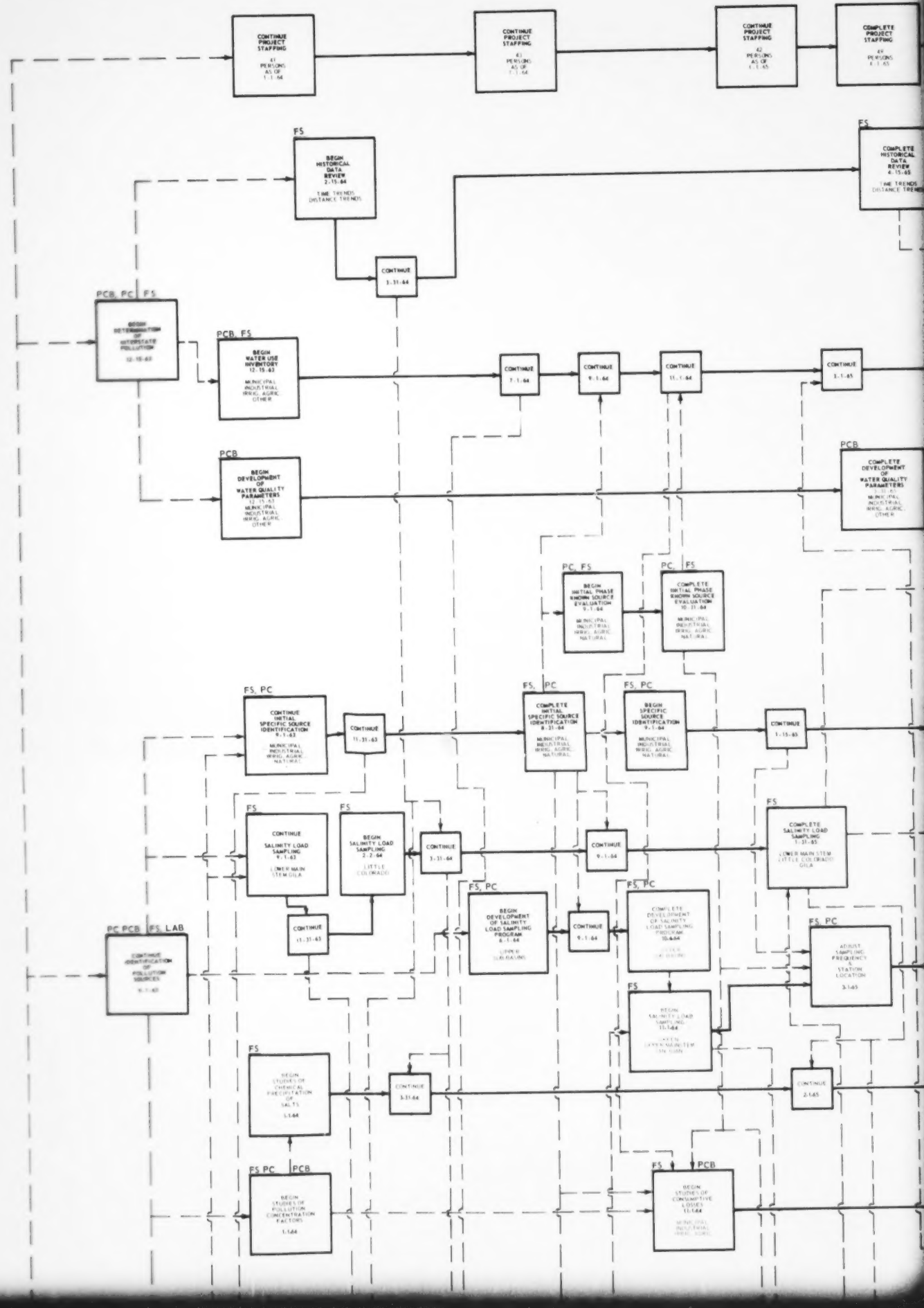
Sub-Basins

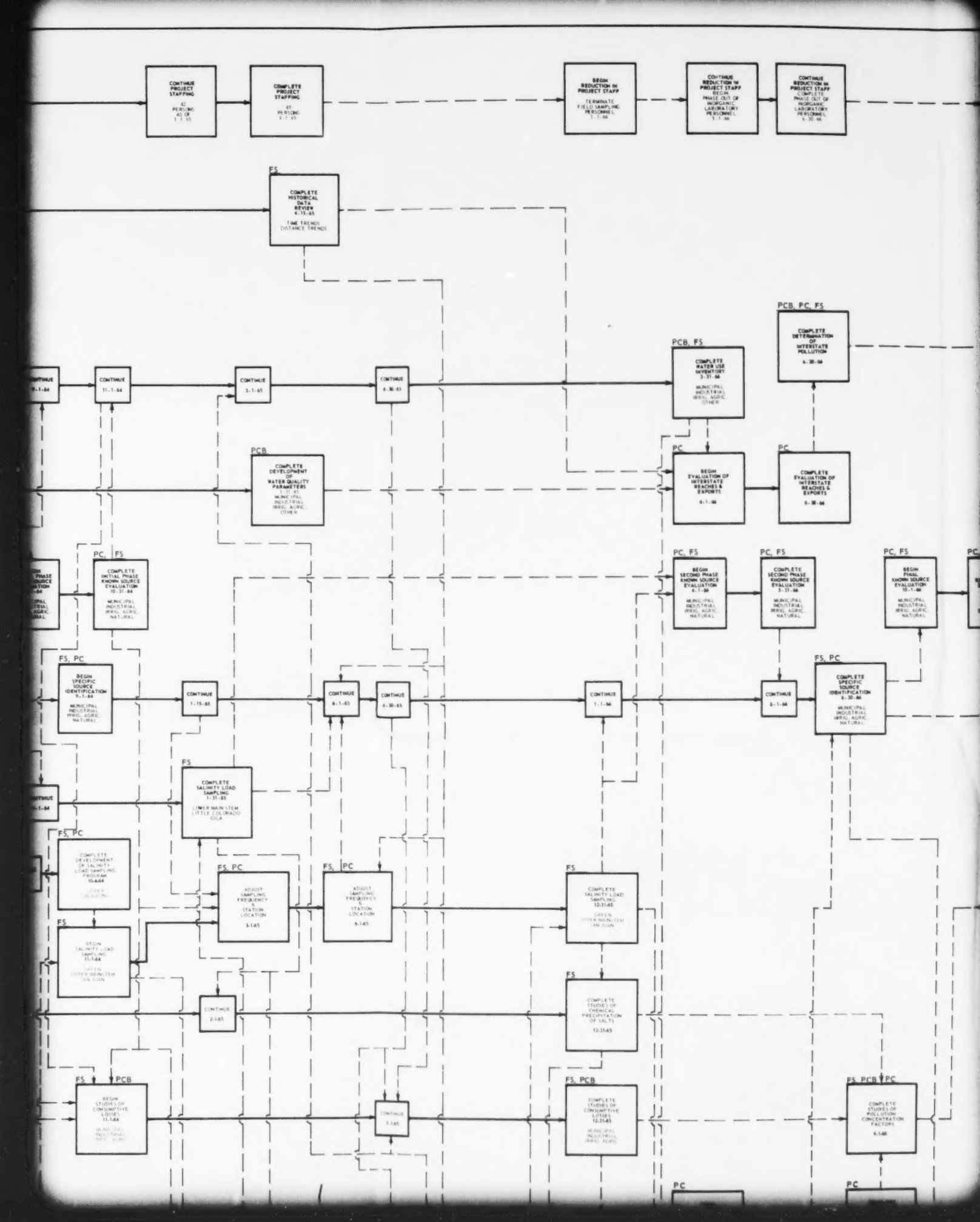
- LMS — Lower Main Stem
- SC — Southern California
- GLC — Gila & Little Colorado
- UB — Upper Basin

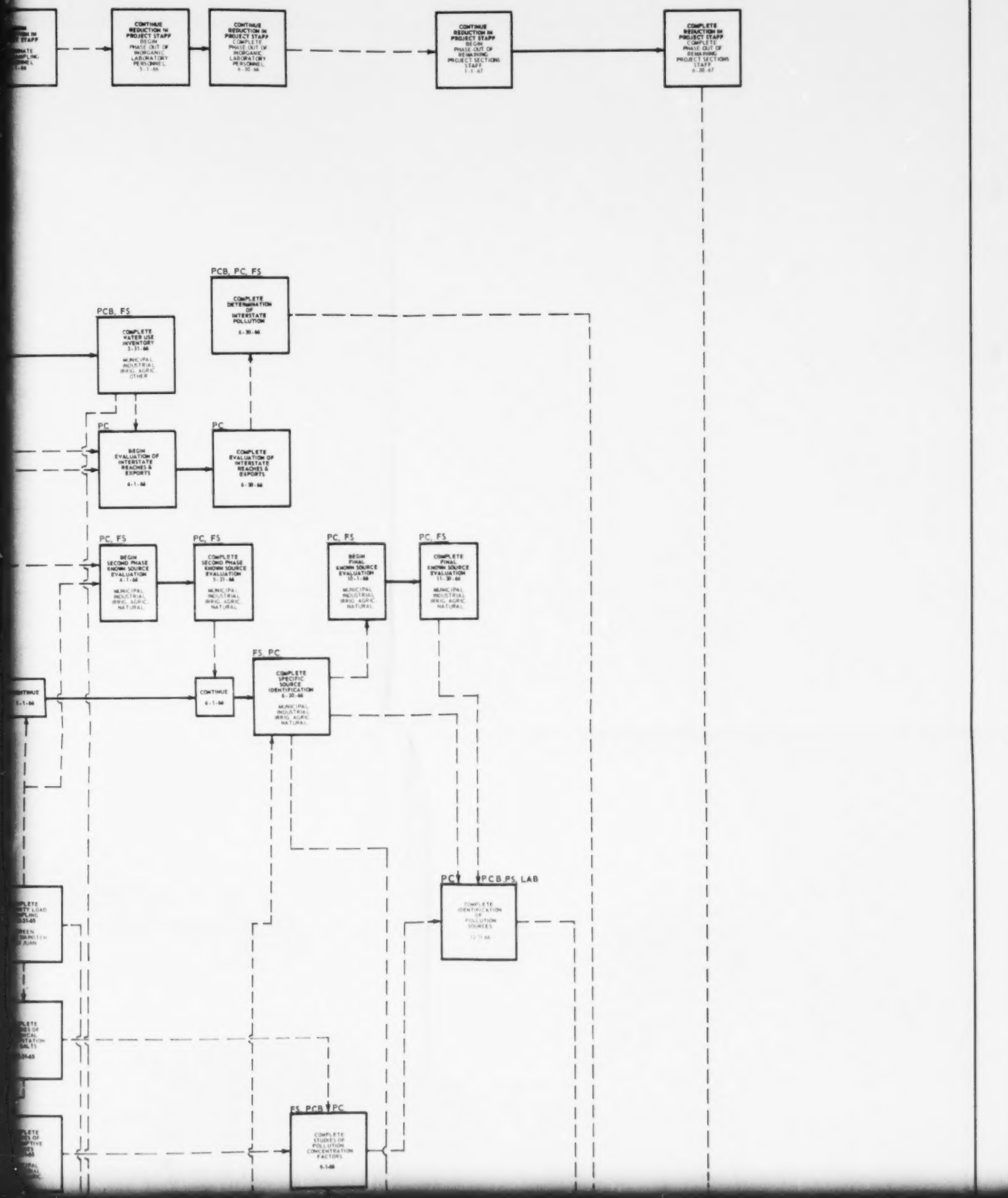
Note: Upper Basin Includes Green, Upper Main Stem, and San Juan Sub-Basins

Est. Man Months By Types of Personnel

- (1) Engineer
- (1) Clerk-Stenographer


CONTINUE PROJECT STAFFING
41 PERSONS AS OF 1-1-64
CONTINUE PROJECT STAFFING
43 PERSONS AS OF 1-1-64
CONTINUE PROJECT STAFFING
42 PERSONS AS OF 1-1-65
COMPLETE PROJECT STAFFING
49 PERSONS 1-1-65
FS
BEGIN HISTORICAL DATA REVIEW 2-15-64
TIME TRENDS DISTANCE TRENDS
COMPLETE HISTORICAL DATA REVIEW 4-15-65
TIME TRENDS DISTANCE TRENDS
CONTINUE 3-31-64
PCB, PC, FS
BEGIN DETERMINATION OF INTERSTATE POLLUTION 12-15-63
PCB, FS
BEGIN WATER USE INVENTORY 12-15-63
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. OTHER
CONTINUE 7-1-64
CONTINUE 9-1-64
CONTINUE 11-1-64
CONTINUE 3-1-65
PCB
BEGIN DEVELOPMENT OF WATER QUALITY PARAMETERS 12-15-63
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. OTHER
PCB
COMPLETE DEVELOPMENT OF WATER QUALITY PARAMETERS 3-1-65
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. OTHER
PC, FS
BEGIN INITIAL PHASE KNOWN SOURCE EVALUATION 9-1-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
PC, FS
COMPLETE INITIAL PHASE KNOWN SOURCE EVALUATION 10-31-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
FS, PC
CONTINUE INITIAL SPECIFIC SOURCE IDENTIFICATION 9-1-63
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
CONTINUE 11-31-63
FS, PC
COMPLETE INITIAL SPECIFIC SOURCE IDENTIFICATION 8-31-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
FS, PC
BEGIN SPECIFIC SOURCE IDENTIFICATION 9-1-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
CONTINUE 1-15-65
FS
CONTINUE SALINITY LOAD SAMPLING 9-1-63
LOWER MAIN STEM GILA
FS
BEGIN SALINITY LOAD SAMPLING 2-2-64
LITTLE COLORADO
CONTINUE 3-31-64
CONTINUE 9-1-64
FS
COMPLETE SALINITY LOAD SAMPLING 1-31-65
LOWER MAIN STEM LITTLE COLORADO GILA
CONTINUE 1-31-63
FS, PC
BEGIN DEVELOPMENT OF SALINITY LOAD SAMPLING PROGRAM 6-1-64
LOWER COLORADO
CONTINUE 9-1-64
FS, PC
COMPLETE DEVELOPMENT OF SALINITY LOAD SAMPLING PROGRAM 10-64
LOWER COLORADO
FS, PC
ADJUST SAMPLING FREQUENCY & STATION LOCATION 3-1-65
PC PCB FS LAB
CONTINUE IDENTIFICATION OF POLLUTION SOURCES 6-1-65
FS
BEGIN SALINITY LOAD SAMPLING 11-1-64
LOWER COLORADO MAIN STEM
FS
BEGIN STUDIES OF CHEMICAL PRECIPITATION OF SALTS 1-1-64
CONTINUE 3-31-64
CONTINUE 2-1-65
FS, PC
PCB
BEGIN STUDIES OF POLLUTION CONCENTRATION FACTORS 1-1-64
FS
PCB
BEGIN STUDIES OF CONSUMPTIVE LOSSES 11-1-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC.


CONTINUE PROJECT STAFFING
42 PERSONS AS OF 1-1-65
COMPLETE PROJECT STAFFING
69 PERSONS 4-1-65
BEGIN REDUCTION IN PROJECT STAFF
TERMINATE FIELD SAMPLING PERSONNEL 1-1-66
CONTINUE REDUCTION IN PROJECT STAFF
BEGIN PHASE OUT OF INORGANIC LABORATORY PERSONNEL 5-1-66
CONTINUE REDUCTION IN PROJECT STAFF
COMPLETE PHASE OUT OF INORGANIC LABORATORY PERSONNEL 6-30-66
FS
COMPLETE HISTORICAL DATA REVIEW 6-15-65
TIME TRENDS DISTANCE TRENDS
PCB, PC, FS
COMPLETE DETERMINATION OF INTERSTATE POLLUTION 6-30-66
PCB, FS
COMPLETE WATER USE INVENTORY 3-31-66
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. OTHER
CONTINUE 11-1-64
CONTINUE 3-1-65
CONTINUE 6-30-65
PCB
COMPLETE DEVELOPMENT OF WATER QUALITY PARAMETERS 7-1-65
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. OTHER
PC
BEGIN EVALUATION OF INTERSTATE REACHES & EXPORTS 6-1-66
PC
COMPLETE EVALUATION OF INTERSTATE REACHES & EXPORTS 6-30-66
PC, FS
COMPLETE INITIAL PHASE KNOWN SOURCE EVALUATION 10-31-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
PC, FS
BEGIN SECOND PHASE KNOWN SOURCE EVALUATION 6-1-66
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
PC, FS
COMPLETE SECOND PHASE KNOWN SOURCE EVALUATION 3-31-66
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
PC, FS
BEGIN FINAL KNOWN SOURCE EVALUATION 10-1-66
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
FS, PC
BEGIN SPECIFIC SOURCE IDENTIFICATION 9-1-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
CONTINUE 1-15-65
CONTINUE 6-1-65
CONTINUE 6-30-65
CONTINUE 1-1-66
CONTINUE 6-1-66
FS, PC
COMPLETE SPECIFIC SOURCE IDENTIFICATION 6-30-66
MUNICIPAL INDUSTRIAL IRRIG. AGRIC. NATURAL
FS
COMPLETE SALINITY LOAD SAMPLING 1-31-65
LOWER MAIN STEM LITTLE COLORADO GILA
FS, PC
COMPLETE DEVELOPMENT OF SALINITY LOAD SAMPLING PROGRAM 10-6-64
LOWER COLORADO
FS, PC
ADJUST SAMPLING FREQUENCY & STATION LOCATION 3-1-65
FS, PC
ADJUST SAMPLING FREQUENCY & STATION LOCATION 6-1-65
FS
COMPLETE SALINITY LOAD SAMPLING 12-31-65
GREEN UPPER MAIN STEM SAN JUAN
FS
BEGIN SALINITY LOAD SAMPLING 11-1-64
GREEN UPPER MAIN STEM SAN JUAN
CONTINUE 2-1-65
FS
COMPLETE STUDIES OF CHEMICAL PRECIPITATION OF SALTS 12-31-65
FS, PCB
BEGIN STUDIES OF CONSUMPTIVE LOSSES 11-1-64
MUNICIPAL INDUSTRIAL IRRIG. AGRIC.
CONTINUE 7-1-65
FS, PCB
COMPLETE STUDIES OF CONSUMPTIVE LOSSES 12-31-65
MUNICIPAL INDUSTRIAL IRRIG. AGRIC.
FS, PCB, PC
COMPLETE STUDIES OF POLLUTION CONCENTRATION FACTORS 6-1-66
PC
PC


CONTINUE REDUCTION IN PROJECT STAFF
BEGIN PHASE OUT OF INORGANIC LABORATORY PERSONNEL
5-1-66
CONTINUE REDUCTION IN PROJECT STAFF
COMPLETE PHASE OUT OF INORGANIC LABORATORY PERSONNEL
6-30-66
CONTINUE REDUCTION IN PROJECT STAFF
BEGIN PHASE OUT OF REMAINING PROJECT SECTIONS STAFF
1-1-67
COMPLETE REDUCTION IN PROJECT STAFF
COMPLETE PHASE OUT OF REMAINING PROJECT SECTIONS STAFF
6-30-67
PCB, PC, FS
COMPLETE DETERMINATION OF INTERSTATE POLLUTION
6-30-66
PCB, FS
COMPLETE WATER USE INVENTORY
3-31-66
MUNICIPAL
INDUSTRIAL
IRRIG. AGRIC.
OTHER
PC
BEGIN EVALUATION OF INTERSTATE REACHES & REPORTS
6-1-66
PC
COMPLETE EVALUATION OF INTERSTATE REACHES & REPORTS
9-30-66
PC, FS
BEGIN SECOND PHASE KNOWN SOURCE EVALUATION
6-1-66
MUNICIPAL
INDUSTRIAL
IRRIG. AGRIC.
NATURAL
PC, FS
COMPLETE SECOND PHASE KNOWN SOURCE EVALUATION
9-30-66
MUNICIPAL
INDUSTRIAL
IRRIG. AGRIC.
NATURAL
PC, FS
BEGIN FINAL KNOWN SOURCE EVALUATION
10-1-66
MUNICIPAL
INDUSTRIAL
IRRIG. AGRIC.
NATURAL
PC, FS
COMPLETE FINAL KNOWN SOURCE EVALUATION
11-30-66
MUNICIPAL
INDUSTRIAL
IRRIG. AGRIC.
NATURAL
CONTINUE
6-1-66
FS, PC
COMPLETE SPECIFIC SOURCE IDENTIFICATION
6-30-66
MUNICIPAL
INDUSTRIAL
IRRIG. AGRIC.
NATURAL
PC
PCB, PS, LAB
COMPLETE IDENTIFICATION OF POLLUTION SOURCES
FS, PCB, PC
COMPLETE STUDIES OF POLLUTION CONCENTRATION FACTORS
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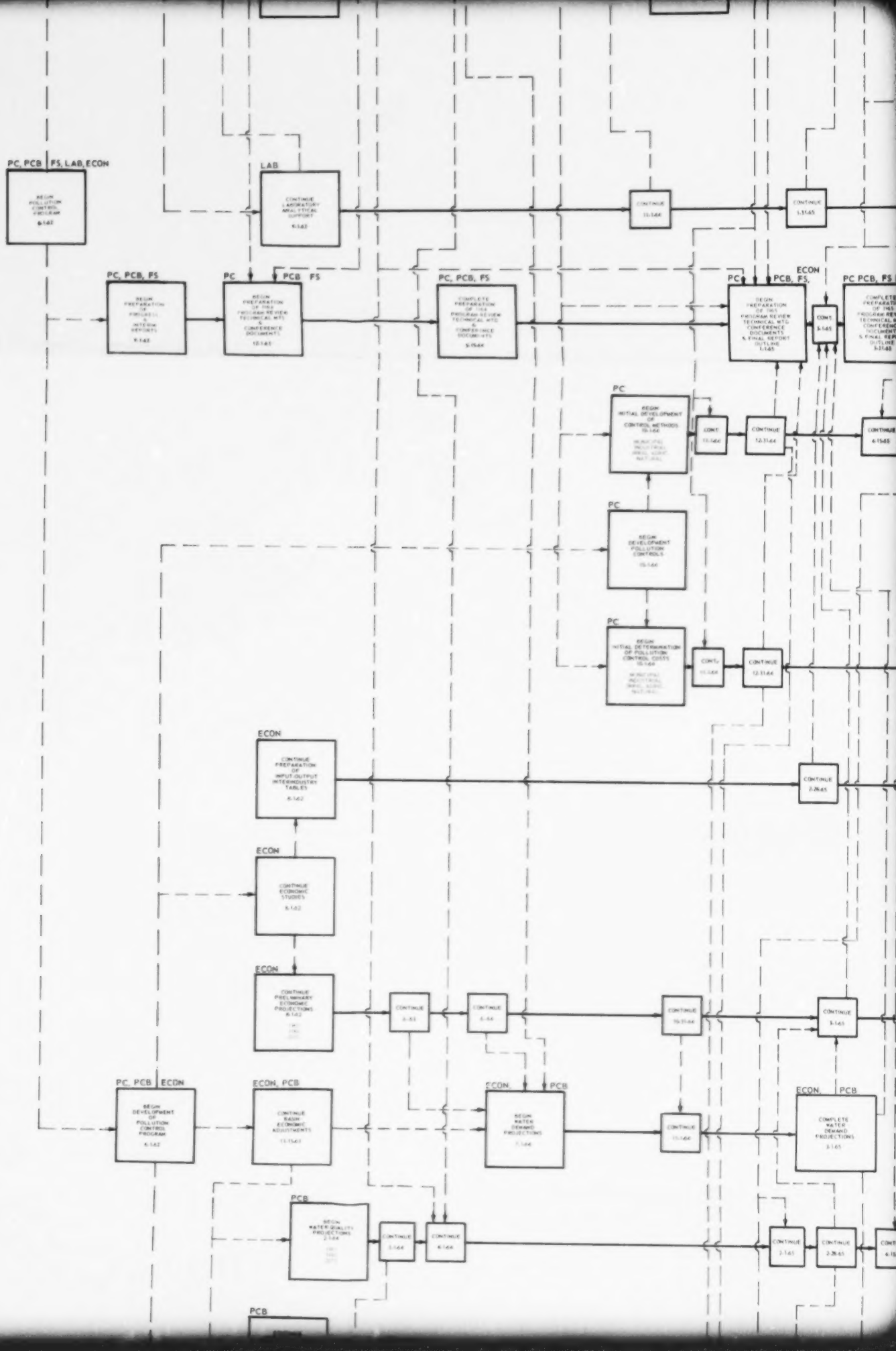
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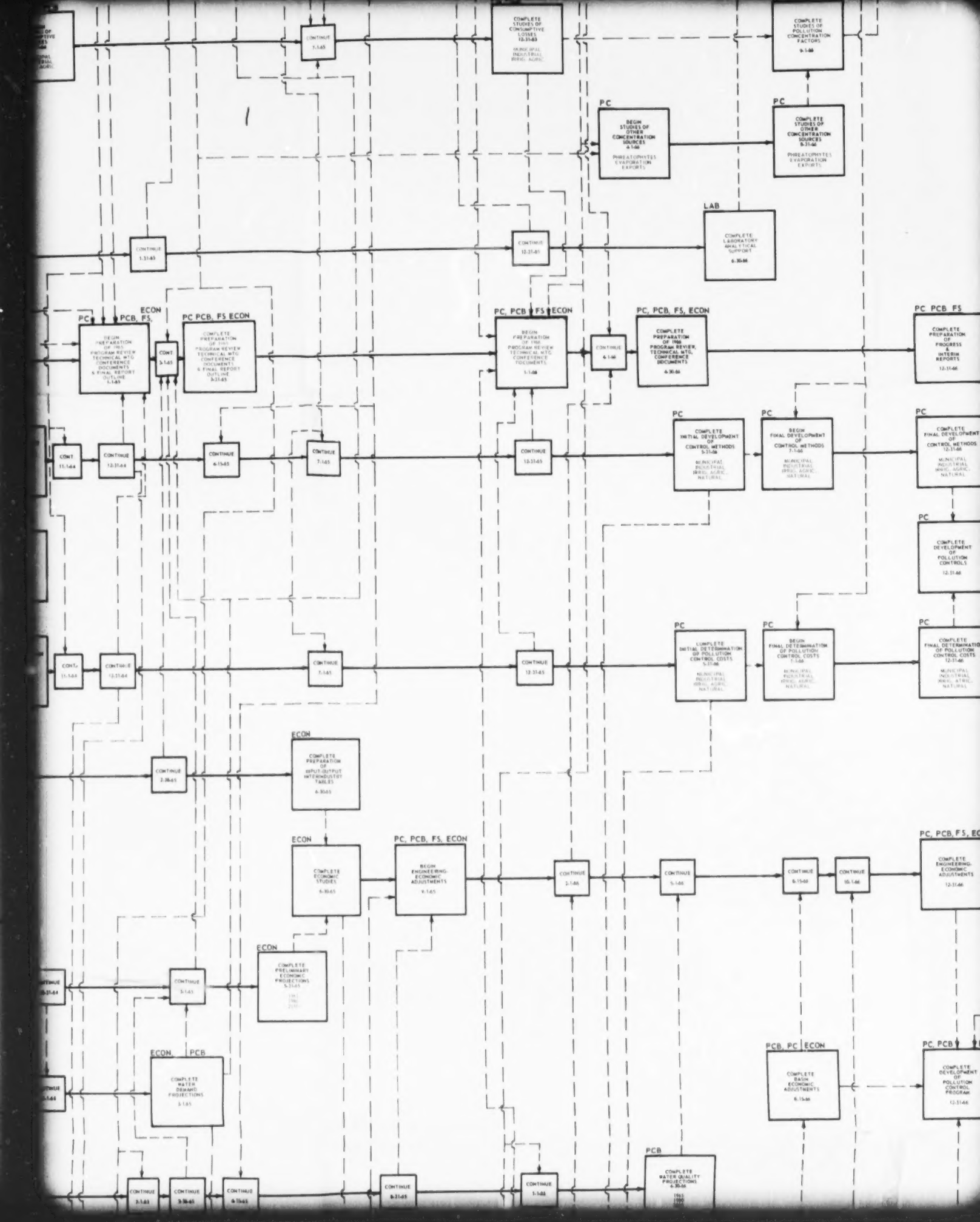
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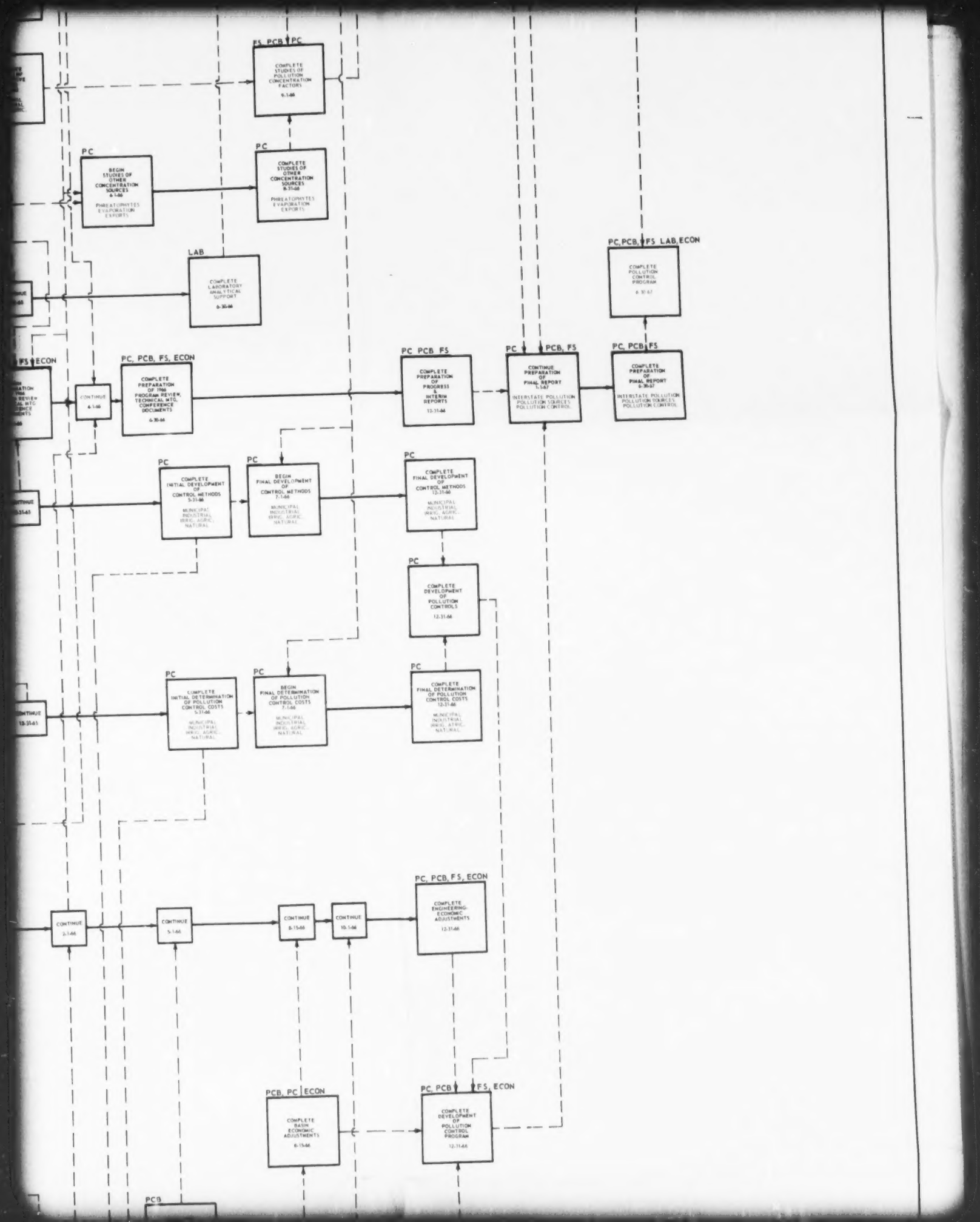
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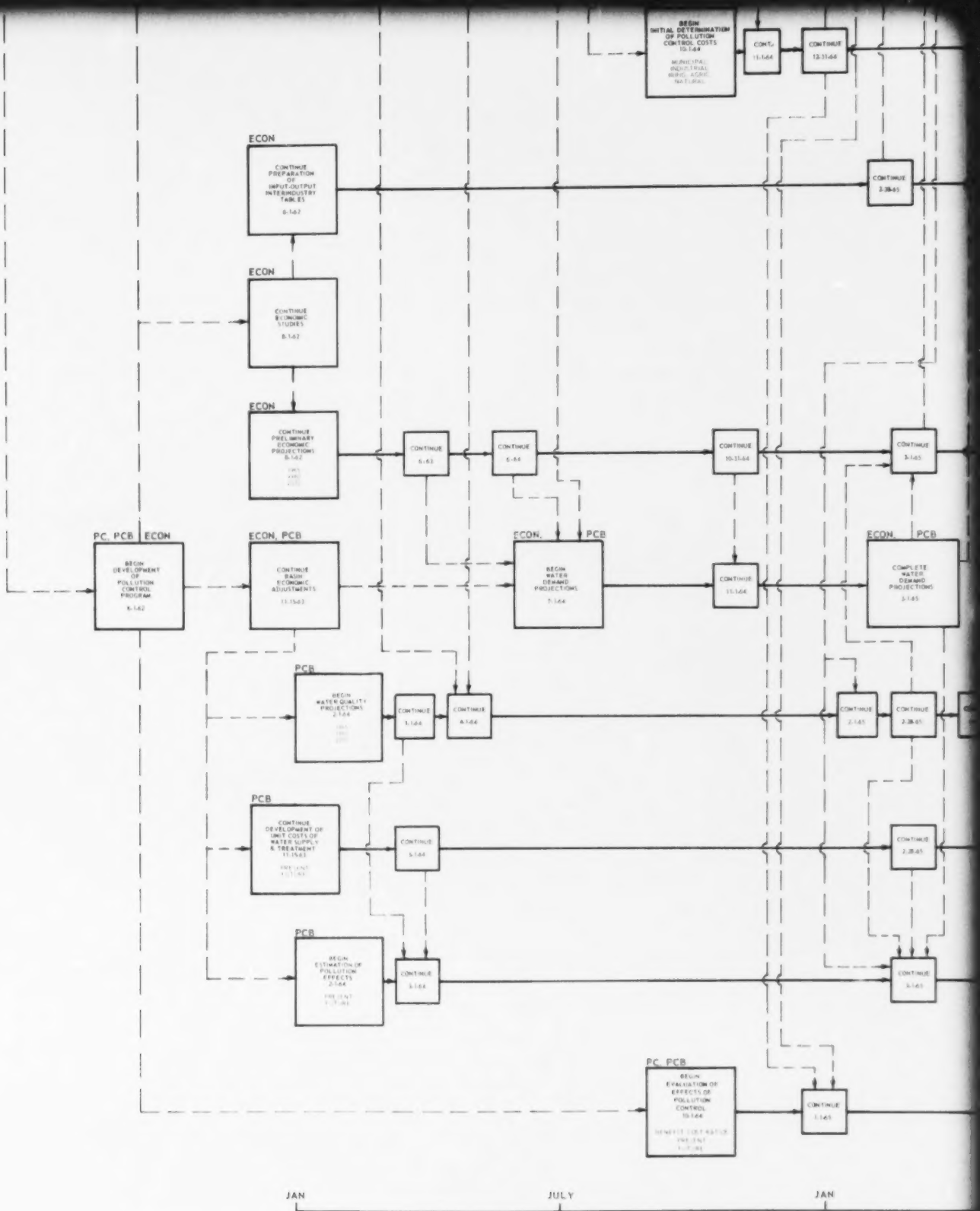
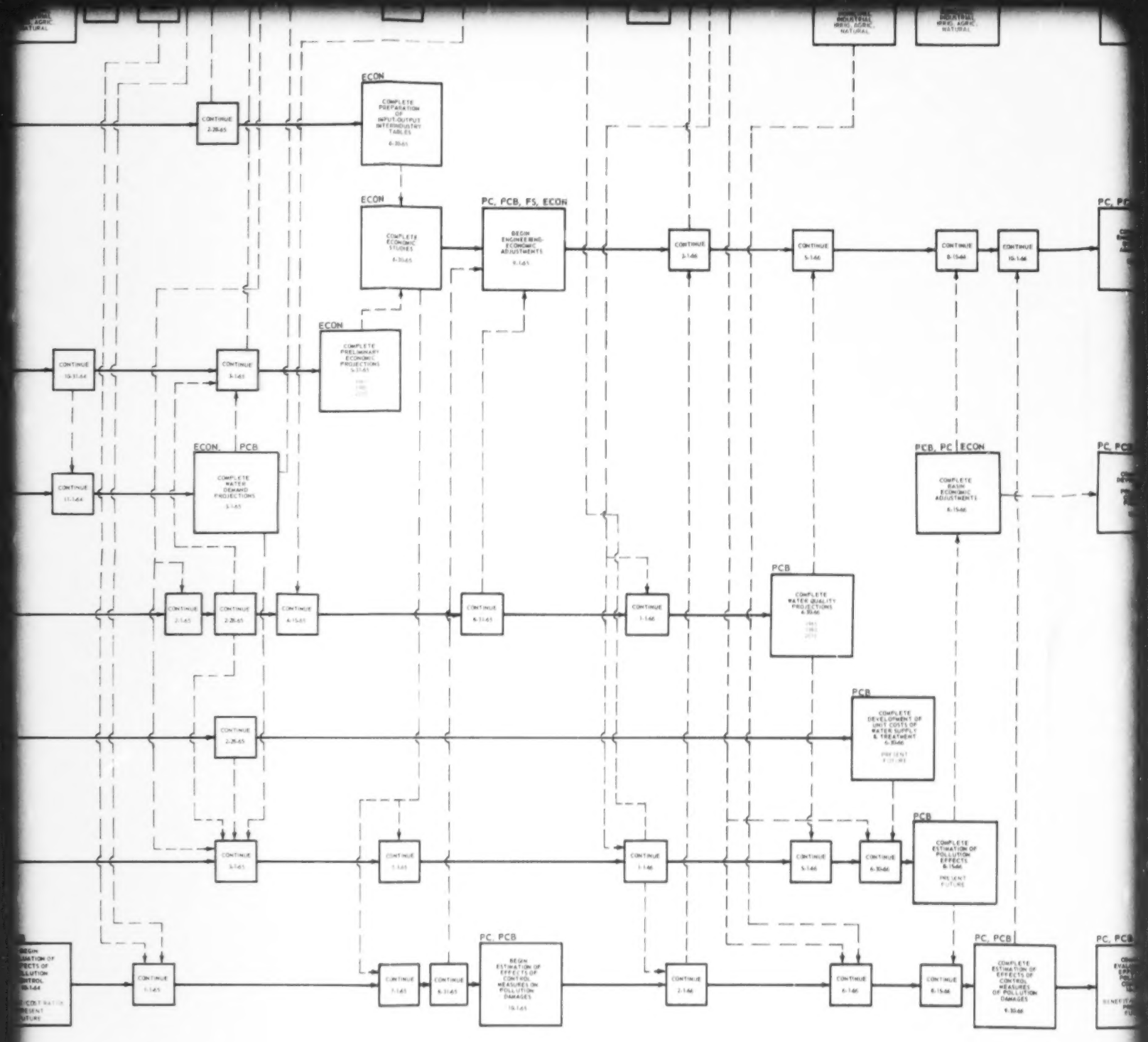



NOTE: ACTIVITY DATES PRIOR TO JAN 1, 1964
ARE NOT PLOTTED ON TIME SCALE.

INITIALS ON TO
RESPONSIBILITY



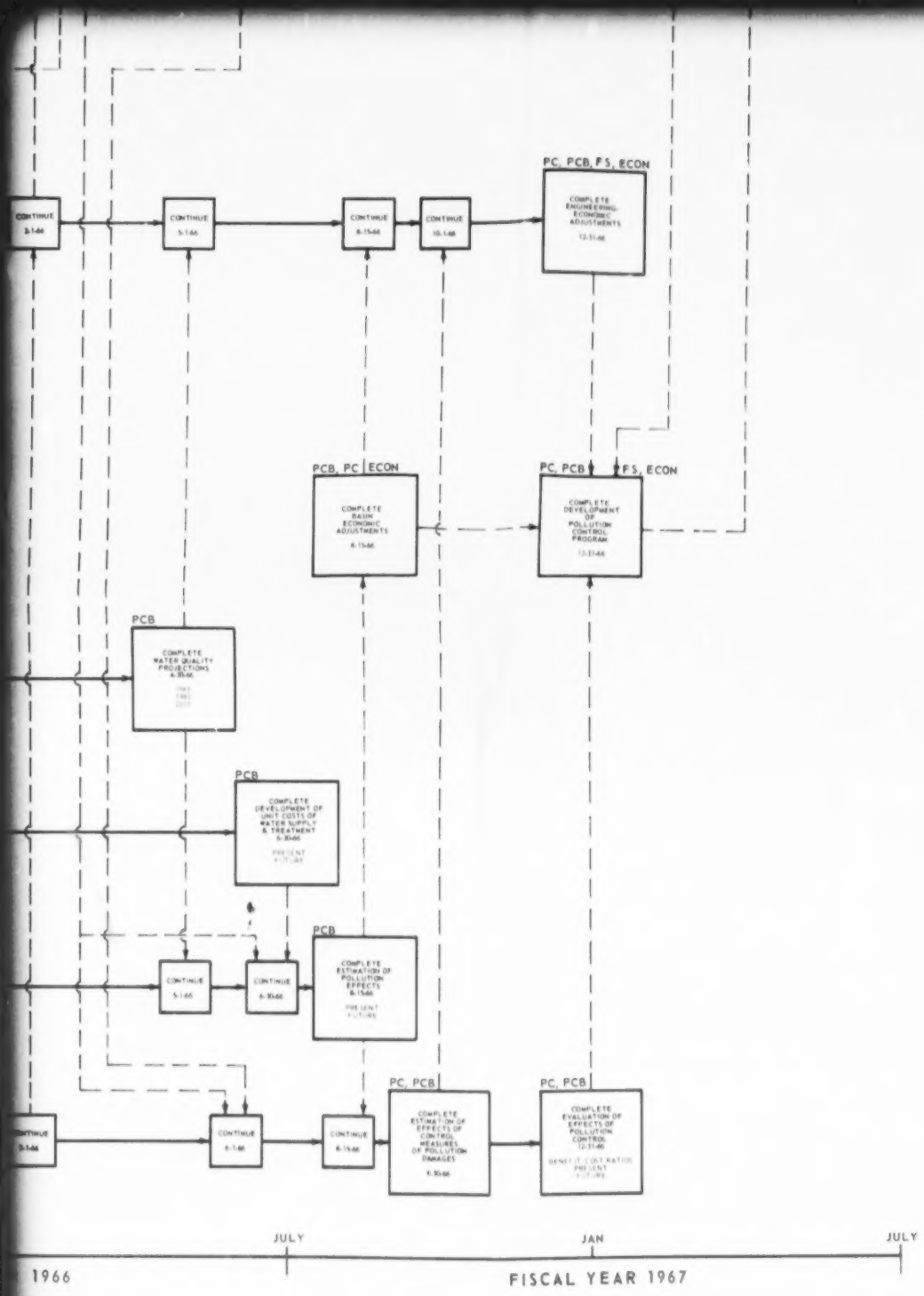

## LEGEND

INDICATES WORK PERFORMED

NON-WORK TASK, INDICATES NECESSARY INTER-RELATIONSHIP, TRANSMITTAL OF DATA, OR ACTIVITY RELATIONSHIP

INITIALS ON TOP OF ACTIVITY BOXES DENOTE PROJECT SECTION RESPONSIBILITY:

| | |
|---|---|
| PC | POLLUTION CONTROL |
| PCB | POLLUTION CONTROL BENEFITS |
| FS | FIELD STATION |
| LAB | LABORATORY |
| ECON | ECONOMIC CONTRACTOR |




# COLORADO RIVER BASIN WATER QUALITY CONTROL PROJECT

## ACTIVITIES SEQUENCE POLLUTION CONTROL PROGRAM

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VIII DENVER, COLO.